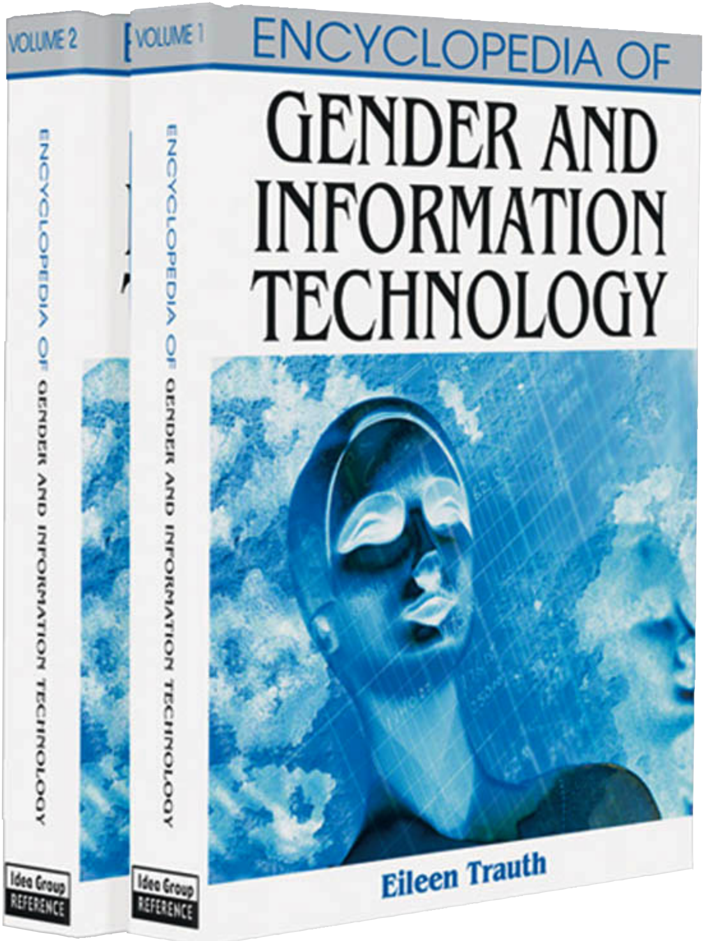
VOLUME 2
ENCYCLOPEDIA OF GENDER AND INFORMATION TECHNOLOGY
Idea Group REFERENCE
VOLUME 1
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GENDER AND INFORMATION TECHNOLOGY
ENCYCLOPEDIA OF GENDER AND INFORMATION TECHNOLOGY
Eileen Trauth
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Encyclopedia of Gender and Information Technology

Eileen M. Trauth
The Pennsylvania State University, USA

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Foreword

It is commonly assumed that we are now living in a new knowledge economy, a post-industrial society. Groundbreaking developments in digitalisation and biotechnologies have led cyber gurus to assert that everything in the digital future will be different. Industrial technology may have had a patriarchal character, but digital technologies, based on brain rather than brawn, on networks rather than hierarchy, herald a new relationship between women and machines. Perhaps the link between technology and male privilege is finally being severed.

The realities of women's lives belie these simple generalisations. Certainly we are living in a very different world than that of even 30 years ago, and digital technologies increasingly mediate every area of our lives. This makes it even more imperative that we examine the extent to which existing societal patterns of gender inequality are transformed or reproduced in a new technological guise.

So, I am delighted that Eileen Trauth has taken on the mammoth task of bringing what is now a vast literature on gender and information technology together in these two volumes. In recent years, there has been a great deal of feminist writing on information and communication technologies. Studies on the Internet, cyberspace, and computer science, for example, have strengthened our analysis of how technology as a culture is implicated in the construction of masculinity. It demonstrates that the symbolic representation of technology remains sharply gendered. At the same time, feminist theory increasingly works from the basis that neither masculinity nor femininity are fixed, unitary categories but rather they are constructed in relation to each other. As a result, we now have a much more complex understanding of gender, of technology, and of the mutually-shaping relationship between them.

Cutting through the hype, this encyclopedia examines the relationship between gender and technology in all the major spheres of our lives. The theoretical approach that it adopts is much needed in an age when deep-seated technological determinism underpins much of the current debate on subjects as diverse as the ecological crisis, food safety, and genetic engineering. This determinist view represents technology as a separate sphere, developing independently of society, and can lead to pessimism about the possibilities for change. The rich collection of articles collected here certainly points in the opposite direction, providing a multiplicity of examples of activities, campaigns, and programs that are reshaping the landscape of women's relationships with machines.

The encyclopedia has many strengths, but there are two in particular that I would like to mention. The first is its interdisciplinary nature. The strength of gender theory over the last three decades has been its ability to cut across traditional disciplinary divides that not only made women invisible, but produced narrow, limited forms of knowledge. The most exciting developments in social science have been in areas that crosscut these old boundaries, and this encyclopedia exemplifies the fruitfulness of this approach. The authors cover a huge range of disciplines and approaches, and we are the richer for it.

The other notable feature of the book is that it uniquely contains contributions by authors from all over the world. Contemporary feminist studies of technology are characterised by more sensitivity to "the politics of difference" than some of the earlier literature. There is a much clearer realisation that gender, that what it is to be a woman, is experienced everywhere through such mediations as race, age, class, sexual orientation, history, and colonialism. Information technologies clearly have very different implications for Third World and First World women, within and between regions and countries. To date, this literature has been dispersed and hard to find. Now, given the comprehensive scope of this encyclopdia, we will be able to compare women's situation in different contexts, and our analysis will be enriched as a result.

I highly recommend these two volumes. They will be invaluable not only for academics and students, but for policy makers, educators, and the interested general reader. The authors represent a wealth of expertise and are at the leading edge of research in this area. If we are to transform gender power relations in the 21st century, we need a fully-rounded understanding of the relationship between gender and information technology. Eileen Trauth can be congratulated for providing us with just that.

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January 2006

Preface

As information technology has spread to all corners of the world and to all aspects of personal and work life, so too, has grown an interest in understanding more about the diverse characteristics of those who use, develop, and are affected by information technology (IT). This is a significant development because understanding the diverse characteristics of both developers and users has ramifications for the way in which work is done, user requirements for systems are understood, and interaction with computer-based tools is accomplished. One important aspect of this human diversity is gender. What has accompanied this increased interest in the role of gender diversity in understanding IT development and use, in recent years, has been heightened research interest in the influence of gender on information systems and technology.

As a result, a large and diffuse body of research related to the role of gender in human interactions with information technology has emerged in recent years. This body of research spans a number of disciplines including: information science and technology; information systems; computer science; engineering; education; women's studies; gender studies; labor studies; human resource management; and science, technology, and society. The focus of this research has been on issues such as similarities and differences between women's and men's use of information technology, variation in relationship to IT among members of each gender group, the effect of gender combined with other diversity characteristics (such as race or ethnicity) on IT use, and the underrepresentation of women in the IT profession. The audience for this research includes parents, educators, managers, policy makers, and other researchers. However, because this literature is located in so many different disciplines a number of problems have arisen. First, for students and scholars, it is difficult to locate the corpus of relevant gender research literature when one wants to learn about or is engaged in gender and IT research. Second, it is difficult for educators, policy makers, managers, and other consumers of this literature to find the relevant material. Consequently, there is a need to bring this research literature together into a single reference source.

The idea for a compilation of research on the topic of gender and information technology originated in 2001. While attending a panel on women and IT at an information systems conference in Australia, several of us who are engaged in gender and IT research bemoaned the lack of coherence in the research. The problem, as we saw it, was that too little research is informed by the existing literature. Instead, too much research appears to be informed by anecdotal data or personal bias. Hence, current research on gender and IT is making less of a contribution to cumulative knowledge about this topic and less of an impact in addressing the issues than it could. At that gathering, we began to talk about the need for a book that would bring together this disparate body of research literature. The opportunity to produce such a book came three years later when Dr. Mehdi Khosrow-Pour of Idea Group Inc. asked me to edit an encyclopedia on the topic of gender and IT. In accepting this invitation, my goal for this book was: (1) to bring together the research literature from all the different disciplines that are producing research about gender and information technology; (2) to bring together the gender and IT research from around the world; and (3) to produce a comprehensive resource that could be the first source to which people would turn to learn about the current state of research on gender and information technology.

What has resulted is this two-volume *Encyclopedia of Gender and Information Technology.* It is an international compilation of research on the topic of gender and information technology, representing a broad range of perspectives. Contributions to this important publication have been made by scholars throughout the world with notable research portfolios and expertise, as well as by emerging investigators. This encyclopedia provides comprehensive coverage and definitions of the most important issues, concepts, trends, and research devoted to the topic of gender and IT. It contains more than 200 articles highlighting this state-of-the-art research. These articles are written by scholars from around the world who are engaged with research into the influence of gender on the development and use of information technology as well as the impact of information technology on men and women. These articles include extensive bibliographies that, taken together, represent an exhaustive reference source for both the interested reader and the scholar engaged in research in the area of gender and IT.

In order to ensure that this encyclopedia has both geographical and disciplinary breadth, an international Advisory Board was established. The members of this Advisory Board introduce this volume by presenting overviews of their research programs in order to illustrate the ways in which the topic of gender and IT is being addressed in different countries.

To assist readers in navigating and identifying needed information, this two-volume encyclopedia has been organized by listing all entries in alphabetical order by title throughout the two volumes, and by including the title in the "Table of Contents" in the beginning of each volume. This important new publication is being distributed worldwide among academic and professional institutions and will be instrumental in providing researchers, scholars, students, and professionals with access to the latest knowledge related to research on women and men with respect to information technology.

Eileen M. Trauth, PhD
Editor-in-Chief

Acknowledgments

As editor of this encyclopedia, I would like to acknowledge the help of those individuals involved in the various phases of this project, without whose support this encyclopedia could not have been satisfactorily completed. I would like to begin by thanking Dr. Mehdi Khosrow-Pour of Idea Group Inc. for inviting me to undertake a project that I had wanted to do for several years. I would also like to thank the staff members Renée Davies and Michelle Potter at Idea Group Inc. who worked closely with me on the production of this encyclopedia.

I would like to thank the members of the Advisory Board—Alison Adam, Jane Margolis, Helen Richardson, and Liisa von Hellens—for their help in recruiting contributions to this encyclopedia and for writing the introductory articles for it. I would also like to thank the authors and the reviewers for their contributions to this two-volume encyclopedia. Without the interest and commitment of individuals around the world who are engaged in gender and IT research, this encyclopedia would not have been possible.

I would like to extend my deepest gratitude to my colleagues in the College of Information Sciences and Technology at The Pennsylvania State University who made this encyclopedia a reality. They helped me shepherd each article through the process from solicitation and proposal, to submission, review, and revision, to the final product. This encyclopedia could not have been accomplished without their diligence and dedication. Three research assistants—Haiyan Huang and Allison Morgan, working under the direction of Jeria Quesenberry—learned, firsthand, about the trials and tribulations of academic publishing as they developed the encyclopedia Web site, managed the article submission system, tracked down reviews, reminded authors, followed-up on revisions, and collated the finished product. David Hall, Associate Dean for Research, provided resources when necessary to complete this project, our Information Technology Office, and in particular, Steve Murgas and Ed Putt, who helped us with the project Web site and submission system, and Tracy Ray from our Research Office saw the final manuscript to completion.

Finally, I would like to thank Kathy Driehaus for her understanding and support, and for patiently listening to me talk about this project.

Eileen M. Trauth, PhD
State College, Pennsylvania, USA
November 2005

About the Editor

Eileen M. Trauth, PhD, is a professor of information sciences and technology and director of the Center for the Information Society at The Pennsylvania State University, USA. Her research is concerned with societal, cultural, and organizational influences on information technology, information technology work, and the information technology workforce. Her investigation of socio-cultural influences on the emergence of Ireland's information economy is published in her book, *The Culture of an Information Economy: Influences and Impacts in the Republic of Ireland.* She is currently engaged in a multi-country study of women in the information technology workforce in Australia, New Zealand, Ireland, and the U.S. Dr. Trauth has published nine books and over 100 research papers on her work. She is an associate editor of *Information and Organization* and serves on the editorial boards of several international journals. Dr. Trauth received her PhD in information science from the University of Pittsburgh.

An Agenda for Research on Gender Diversity in the Global Information Economy

A

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INTRODUCTION

There has been considerable interest of late in the topic of diversity in the IT field. This topic engages the spectrum of IT stakeholders from academics to funding agencies to industry groups to practitioners. Academic research on diversity has appeared in special issues of journals such as *Information Technology and People* (Adam, Howcroft & Richardson, 2002) and has become a conference theme for ACM SIGMIS CPR (Trauth, 2003) and IFIP 8.2 (Trauth, Howcroft, Fitzgerald, Butler, & DeGross, 2006). In the United States the National Science Foundation has funded gender research under the rubrics of the IT Workforce (ITWF), Broader Participation (BP), and Science Technology Engineering and Mathematics (STEM) funding streams. Industry groups such as the Information Technology Association of America (ITAA) have sponsored conferences dealing with diversity. Perusal of corporate Web sites gives evidence of the incorporation of diversity goals into corporate policy.

The focus of attention—whether from a practitioner or an academic perspective—is generally about how to achieve greater diversity in the IT labor force. A significant component of this diversity quest is the recruitment and retention of women in the IT field. Underlying this discourse, however, is the assumption that we currently possess the conceptual tools to understand the reasons for the lack of gender diversity in the IT field and that we know how to apply this knowledge to the task of redressing this situation. However, there are some of us who would challenge these unexamined assumptions. We would argue that part of the reason for the underrepresentation of women in the IT field is the absence of a sufficient examination of these assumptions. This, in turn, suggests a need for theoretical innovation along with the application of interventions.

In response to this need, a research program has been established at the Center for the Information Society at The Pennsylvania State University. Housed in the College of Information Sciences and Technology, this research program has both theoretical and application goals. The theoretical goal is to broaden the theory base used to understand the underrepresentation of women in the IT field. The application goals are to translate this understanding into public and corporate policy, and curricular interventions. The remainder of this article presents an overview of a research agenda for gender diversity and the IT sector that was established in order to respond in a meaningful and productive manner to the diversity challenges and opportunities being presented to the 21st century IT labor force.

THEORETICAL STANCE

The objective of this research agenda is to develop theoretical tools that help us uncover the meaning behind the statistics about the underrepresentation of women in the IT workforce. It is being achieved by focusing attention on the *differences among women*, that is, the variation that exists within a gender group rather than across the two gender groups. In doing so, this approach stands in contrast to the body of gender and IT research which focuses attention on the *differences between men and women*. The motivation for adopting this theoretical perspective arises from the awareness that gender roles, expectations, and stereotypes regarding women's involvement with information technology vary significantly when factors such as nationality, race, age, sexual orientation, marital status, socio-economic status, and education level are taken into account. To date, data from Australia, Ireland, New Zealand, and the U.S. are being used to articulate and empirically test a theory of individual differences to explain the underrepresentation of women in the IT workforce.

The contribution of the Individual Differences Theory of Gender and IT is that it focuses on differences among women in the ways they experience and respond to characteristics of IT work, the IT workplace, and societal messages about women and IT. The goal of this research is to engage in field-based theory refinement by examining the particular ways that female IT professionals are influenced by and react to the social shaping of both gender identity and IT.

DIVERSITY RESEARCH AGENDA

Elsewhere in this *Encyclopedia* the Individual Differences Theory of Gender and IT is discussed in greater specificity as are details about the theory testing research that has been conducted to date. The purpose of the discussion here is to provide an overview of the research agenda and how it is being enacted.

Field Studies of Gender and IT

Field studies have been conducted in several countries in order to further develop and conceptually test the Theory of Individual Differences as it relates to IT and gender. The purpose of these studies is threefold: (1) to identify characteristics associated with women who have successfully negotiated the IT field, (2) to deepen our understanding of environmental influences on female participation in IT, and (3) to document the variation in definition of male/female competencies, men's work, women's work, and women's responses to generalized societal messages about the IT field as a male domain.

The earliest study in this research program on gender and IT was conducted in Ireland between 1989 and 1999 as part of a larger study of socio-cultural influences in the development of Ireland's IT sector.[1] In that study, gender was not the specific focus of the attention; it was but one of a number of socio-cultural factors being explored (Trauth, 1995, 2000). A subsequent research project, which began in 2003, is investigating the impact of Ireland's information sector on Irish society. In this research, a study of women in the IT sector is an explicit component.[2] Here, the focus is on ways in which the position of women has changed as the information economy has become more central to Ireland's overall economic development (Trauth, 2004).

A third research project was undertaken in Australia and New Zealand in 2000. The focus of this study is on understanding how women negotiate the largely male domain of the information technology profession. A particular emphasis of this study is the influence of race, ethnicity, nationality, and culture on a woman's development as an IT professional (Kvasny & Trauth, 2002; Nielson, von Hellens, Beekjuyzen, & Trauth, 2003; Trauth, Nielsen, & von Hellens, 2000, 2003; von Hellens, Nielsen, & Trauth, 2001).[3] It was in the course of conducting this research that the theoretical perspective of individual differences was first explicitly articulated (Trauth, 2002).

Research in the United States began in 2002 with a multi-year investigation of women in the American IT workforce.[4] The purpose of this research is to empirically refine and test the Individual Differences Theory of Gender and IT (Morgan, Quesenberry, & Trauth, 2004; Quesenberry & Trauth, 2005; Quesenberry et al., 2004; Quesenberry, Trauth, & Morgan, 2006; Trauth, Huang, Morgan, Quesenberry, & Yeo, 2005a; Trauth & Quesenberry, 2005, in press; Trauth, Quesenberry, & Morgan, 2004; Trauth, Quesenberry, & Yeo, 2005b).

Research Methods

While a consistent research methodology and theoretical perspective have been employed in all of these gender studies, the epistemological underpinning has evolved as this research agenda has progressed. Qualitative methods have been employed in each of the projects. This consists of open-ended interviews that are complemented by participant observation and document analysis. The interviews are focused around the life histories of the participants. That is, women IT professionals are asked to describe their educational and career journeys that brought them to their current position in the IT field. These interviews draw from a script but are quite open-ended in structure. They typically last 90 minutes in duration and are recorded for later transcription and analysis.

Since the theoretical lens for this research is directed toward a better understanding of variation in receipt of societal messages and individual responses to them, this research has sought to explore the varied individual and environmental influences on women working in the IT profession. Hence the interview questions probe regional cultural influences, as well as varied individual experiences and influences.

At the outset, the epistemological orientation was completely interpretive. It was chosen over the dominant epistemology—positivism—because the objective was not to conduct hypothesis testing of established constructs. Rather, this research sought to articulate the emergent constructs of the Individual Differences Theory by developing a better understanding of the influences on women in the enactment of their careers. This was pursued by exploring the manifestation of individual differences in the women's work-life narratives. However, as this research agenda has proceeded, more recent projects have moved toward a critical epistemological orientation. As this has occurred, the focus has shifted from an exclusive emphasis on the woman's subjective representation of her career history to her reflection upon (and the researchers' critical analysis of) contradictions, and the role of external forces and power relations in shaping her decisions and behaviors (Howcroft & Trauth, 2004; Kvasny, Greenhill, & Trauth, 2005).

Future Research

Future work in this research agenda will involve further empirical testing of the various constructs of the Individual Differences Theory drawn from the interview data sets. It will also involve more extensive data collection methods such as survey research. Whereas the research, to date, has focused on women at one end of the career pathway—those who are already in the labor force—future work will also extend the examination of individual differences in relation to information technology to secondary school and university women students. The Theory of Individual Differences is also being applied to a study of masculinity and femininity in IT adoption. Finally, this research is becoming incorporated in an investigation of the role of human diversity in the development of a knowledge economy.

In addition to this work, four doctoral candidates are exploring gender diversity in IT in their own dissertation research. Jeria Quesenberry is employing the Individual Differences Theory of Gender and IT in an extension study of the underrepresentation of women in the IT profession. The objective of this study is to more deeply investigate the role of organizational factors in the underrepresentation of women in the IT profession in order to further test some of the constructs in the theory. Haiyan Huang is investigating methods for coping with gender as a feature of cultural diversity when engaging in global, virtual IT development. As part of this research she is examining cross-cultural influences on gender and their implications for work teams. Allison Morgan is employing the Individual Differences Theory of Gender and IT in a study of Web search capabilities of diverse individuals. The objective of this study is to better understand how greater attention given to the diversity of individuals can influence system design in order to overcome the digital divide. Benjamin Yeo is exploring the theme of social exclusion based upon gender as part of his study of socio-cultural factors influencing the development of sustainable knowledge economies in several countries.

CONCLUSION

At the heart of this research agenda on the underrepresentation of women in the IT profession is the recognition that the IT sector is global in nature. Hence, national characteristics, geography, economy, cultural factors, race, and ethnicity must also be taken into consideration when attempting to explain the relationship between gender and information technology. The initial work in this research program emanated from the effort to understand gender as one of a number of socio-cultural factors influencing the development of a nation's information sector. This global perspective has remained an essential feature of our research agenda. The twenty-first century is witnessing greater global dispersion of the IT sector. Therefore, it is fitting, we believe, for a U.S.-based research program to develop an understanding of gender and IT within the context of a better understanding of the global information economy.

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Facing and Changing Reality in the Australian IT Industry

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Despite recent setbacks, the Australian information and communications technology (ICT) industry is one of the fastest growing and innovative sectors of the Australian economy with a sustained average annual growth rate approaching 12%. This is more than two and a half times the average growth rate of the Australian economy as a whole. The ICT industry is a sector in its own right but is also transforming all other industries and areas. In fact, about 60% of ICT professionals work outside the ICT sector. In 2005, Australia had 355,600 employed ICT professionals spread across all sectors of the economy (DCITA, 2006). This represents 3.6% of the workforce and is higher than in Europe (2.5%) and the USA (about 2.8%) (Petersen, Revill, Ward, & Wehmeyer, 2004).

However, recent figures from the Australian Bureau of Statistics (2003) show women comprising only about one fifth of the ICT workforce. There are different ways of measuring female participation and success but the general conclusion is that women are not only in a minority but also are concentrated in the lower level, lower paid, and lower skilled jobs in this industry. The proportion of females employed in ICT roles varies among sub-sectors; telecommunications services and manufacturing sectors are the lowest (18% and 19% females, respectively) and computer services is the highest (26% females).

The gender distribution across core IT roles shows that women are over represented in the groupings that tend to have lower formal qualifications such as computer support technicians. Statistics do not identify jobs that require "hybrid" skill sets (e.g., graphic designer or business analyst) which may be more appealing to many women. Australian labor force statistics also show that women with a background in marketing and public relations dominate occupations in digital industry management. A significant proportion of females are in occupations in the Internet and multimedia, digital industry management, and industry positions requiring high IT proficiency, such as graphic designers and illustrators.

In the tertiary education sector, admission statistics for core IT programs show declining numbers for student retention generally, and for female students in particular. Women with IT qualifications changed from 36.5% out of the total 90,704 individuals with tertiary IT qualifications in 1996 to 30.5% out of 153,183 in 2001 (Bell & Staehr, 2004). A report on industry statistics prepared for the Women in ICT Summit held in September 2005 revealed that the number of entering university students fell by 24% between 2001 and 2003, and that in 2003, of the 11,866 new students enrolling in undergraduate IT degree courses in Australia 80% were male (Department of Communications, Information Technology and the Arts (DCITA), 2005). The Australian Council of Professors and Heads of Information Systems (ACPHIS) which consists of IS professors in business and information technology schools is extremely concerned with the low student numbers and lack of women. This item has been on the agenda at the annual meetings in both 2004 and 2005. Similar concerns have been expressed by the Council of Computer Science heads. These data exist against a backdrop of overall decline in IT/IS majors in business schools, forcing IS schools to downsize their staffs.

A good deal of research and intervention has been carried out to improve the participation of women in the Australian IT industry, but the field is still too new for any conclusions to be drawn about the effectiveness of the large number of intervention programs or to understand the impact of research on perceptions of the problem. The WinIT project (discussed elsewhere in this *Encyclopedia*) is typical of research in this area, aiming to study the results of action programs as well as to investigate perceptions and behavior of potential and existing students and IT personnel. The motivations are also typical, deriving from ethical concerns about equity and representation as well as practical considerations regarding the health of the industry. However, research in this area is complicated by problems in defining the nature of the IT industry and the role that women might play in the industry.

Firstly, a lack of clarity as to what constitutes the IT industry and the rapid rate of change complicate attempts to understand the reasons for the declining participation of women in the IT industry, as well as the declining interest in IT degrees. Concerns regarding equity are based on an "equality" view of women's participation, in which women can do anything that men can do. A "difference" view of women entails considering how women might contribute "special" attributes and skills to a masculinised industry. However, the notion that women who work in the IT industry may provide some important "female" perspective and influence, which would represent and serve the interests of women as an undifferentiated group, is very contentious. The WinIT project has taken a social construction view, regarding the construction of ideas such as "female" and even "information technology" as an ongoing and negotiated process. However, regardless of how "female" is defined, the exclusion of women from an important industry limits the development of the industry within a wider context of social change and limits the capacity of women to negotiate their social identity in the "information society."

Research shows that the "masculinisation" of the IT industry makes it unattractive to many men as well as to most women. To what extent this is associated with other aspects of western culture is not yet clear, since many industries seem to transcend national culture differences. Therefore, it is important to understand how the IT industry may change over time and how the participation of women may be facilitated.

There are many programs, initiatives, and interventions aimed at women and female students across Australia which provide the opportunity not only to take action but also to carry out action research. The interventions for female students are generally: awareness raising, demystifying the industry through role modeling and mentoring; presenting career options; and improving the understanding of how technology fits with business and different industries. Interventions aimed at women are more focused on support and leadership, with themes such as mentoring, preparing for board positions and networking opportunities.

Although the effectiveness of these interventions cannot yet be assessed, there is considerable support in Australia for such programmes. A prime example is the efforts of the Minister for Communications, Information Technology and the Arts, Senator Helen Coonan. She established an Advisory Group to help her plan a Women in ICT summit that was convened in September 2005. Fulfilling an election promise, the Advisory Group was made up of prominent Australian women from both the ICT and education sectors. The Group was established to help identify key issues that needed to be considered at the summit. The intent of the summit was to feature high profile participants representing the industry, government, and academia. Breakout sessions would then focus on four topics: how the ICT professions should be represented; how to make the ICT workplace attractive for women; how to ensure that curriculum design and career advice address Australia's ICT needs; and how to coordinate future activity to enhance women's participation in ICT.

With respect to future activity, the group supported a national approach to enhancing women's participation in ICT while acknowledging that existing bodies already working on the problem would be playing an important role. For example, a National Communications umbrella organization—AWISE (Australian Women in IT and Science Entity) has recently been formed to represent a collaborative voice connecting ICT networks for women and girls. The Founding Board is populated with women active in the area of interventions for women and girls across Australia who are already involved in the many intervention programs run by state and federal government departments, education institutions, and industry organisations that have been introduced to interest more women in ICT education and careers. The group has five goals: to be a national single point of contact; to encourage more females to enter ICT;

to share information and initiatives; to be a centralised national body to influence government and media; and to obtain national funding to support agreed upon initiatives.

The group intends to maintain a national presence for certain initiatives that could result in greater exposure for the ICT industry. This would occur through regular planned awareness-raising activities and programs to either encourage females into the industry or to support them working and studying in the industry. One of the planned initiatives is a national role models day that is currently held in three states across Australia, with the support of national funds and media. This would allow the program to become more regular, more supported, have more exposure, and become part of the "norm". At least three events are planned for 2006. The aim is to have up to 7,000 female students in Australia participating in the events. Another planned initiative is to build on the success of the Queensland WIT scholarships and awards program by running it nationally. In a similar way, having a national scholarship presence would result in greater exposure for women in the industry as well as offer females from all over Australia the opportunity to win a scholarship and be rewarded. A third initiative of the group is setting up a national Board Readiness Program for women working in the industry. Also building on the success of one of Queensland's WIT Programs, this initiative will help women develop the skills and attributes necessary for them to join and contribute successfully to Board positions. The program will provide support, advice, and a structured program for women in the industry.

Australian research is tending towards action research in this area. The reflexive nature of social science research means that investigations into female participation may also contribute to the reproduction or transformation of relevant social factors. However, the effects of earlier research are not yet clear. There is a possibility that the focus on negative factors inhibiting female participation may even contribute to the perpetuation of those factors amongst the subjects studied, in the same way that media attention on the problems in the IT industry may have contributed to declining student interest. Hence, there is a strong motivation to make change while at the same time studying the effects of these changes. In such a rapidly developing industry as IT, we need to move quickly if we are to have any impact.

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Gender and Information Systems Research at the University of Salford

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INTRODUCTION

In this article we showcase the work of the GRIS group at the University of Salford in the United Kingdom. Alison Adam and Helen Richardson have been working in the field of gender and IS for many years and have recently been awarded funding from the European Social Fund (ESF) to research the under-representation of women in the IT labor market in the UK. Claire Keogh and Angela Tattersall are research fellows working on the WINWIT (Women in (North West) Information Technology) and DEPICT (Directing Pay in Information and Communications Technologies) projects and Karenza Moore and Marie Griffiths are research fellows working on the WINIT (Women in Information Technology) project. In this account we discuss the theoretical foundations of our research and our work to give gender and IS research a voice. We then present brief findings from research to date that encompasses the IT labor market, gender and online learning and in particular government strategies purported to encourage women to engage with the information society, gender, and home e-shopping, and the contribution of feminist ethics[1] to IS research.

GIVING A VOICE TO GENDER AND IS

The GRIS group at Salford consists of two faculty members (Adams & Richardson) and four researchers on funded research projects (Griffiths, Keogh, Moore, and Tattersall). In our research, we aim to bring a solidly theorized position based on feminist theory to practical empirical research on women and gender in IT and IS. In taking such an approach we critique work which adopts an often tacit liberal position[2], which does not address underlying reasons for underlying inequalities between the men and women in IT and IS[3]. We see such work as having a political dimension, where inequalities should be identified and described.

The Salford approach is exemplified in a seminal paper by Adam, Howcroft, and Richardson (2004), where we discuss a decade of neglect and reflect on the field of gender and IS, hoping to stimulate a new area of discourse and offer insight into the topic of gender in IS. The basic argument presented is as follows. First, the topic of gender is inadequately studied within the IS discipline. This is evidenced in the dearth of published papers on this topic in highly-ranked IS journals. Second, the concept of gender in IS research largely lacks theorization. IS is a field of research which has its core concern as "the development, use and impact of information technology in business and organizational settings" (Myers & Avison, 2002, p. 3). Within this article we provided a detailed analysis of recent research, which highlights a number of problems as statistical studies often take gender to be an unanalyzed variable. The gender implications of potential transformation, from new information and communication technologies, continues to be ignored. As noted elsewhere (Lohan, 2000; Wacjman, 2000), gender must be taken into account if we are to achieve a fuller understanding of technologies.

When considering the question as to why the issue of gender is largely neglected and under-theorized in the IS literature, one explanation lies in the development of IS as a discipline. The field is comparatively new and many academics are often placed in a minority position within their respective institutions, aligned with a range of diverse disciplines, such as computer science, management science, and organizational science. Many of the disciplines from which IS has arisen have been primarily associated with the functionalist paradigm which focuses on the development and use of information systems in narrow technical terms, often disregarding their organizational context. As a consequence, much time has been preoccupied with resisting technologically deterministic views of technology and by arguing for recognition of social and organizational issues.

This reaction against functionalism has been coupled with a desire for intellectual respectability and the need to create a niche for IS as an emerging discipline. As a result, it is seen as essential that "proper" research topics are established and unfortunately gender does not appear to fall within these parameters. Any claims regarding gender are claims about how we frame our social, political and organizational existence, yet these are seen as potentially threatening to the core of IS. Consequently, this adds to the dearth of research on gender and IS. Hence, we create a self-fulfilling prophecy, as the tacit lack of legitimacy of gender and IS as a research topic results in little or no attempt to progress in the area, and it then becomes viewed as a topic unworthy of publication and projects.

Dichotomizing Gender: A Problem of Statistics and Alternative Approaches

In studies which we critique in Adam et al. (2004), population samples are surveyed and gender is seen as a dichotomous variable, where specific differences in the genders are looked for and where corresponding hypotheses are of the broad form: women will do some behavior less or more than men do the same behavior. We argue that this style of statistical analysis forces gender into polarized masculine and feminine categories, therefore emphasizing differences between the two and reinforcing stereotypes. Statistical studies which cite gender differences can be analyzed endlessly, but at some point one needs to consider the deeper, underlying reasons for women's absence from the technical sphere.

Hence, we wish to contribute to research which goes beyond the traditional commentary of "add-more-women" and are instead pointing towards directions where future research on gender and IS could lead. Members of the GRIS group acted as guest editors for a special issue on gender and IS of the more critically-inspired journal *Information Technology and People* in 2002. This included: an examination of socio-cultural influences on women in the IT profession (Trauth, 2002); a consideration of discourses that represent male and female workers' social and technical skills in the software development industry (Woodfield, 2002); a study of contradiction and resistance in nursing information systems (Wilson, 2002); and an analysis of the role of gender in the domestication of computers in the home environment (Habib & Cornford, 2002). Similarly, a recent paper by Adam (2002) provides a critique of the total neglect of gender issues by IS researchers concerned with the Habermasian notion of emancipation.

GENDER AND THE IT LABOR MARKET

Our research into the UK labor market is funded by three European Social Fund projects. The aim is to consider the underrepresentation of women in the North West UK and throughout England and also to address salary secrets[4] and pay discrimination in the ICT sector[5]. In this section we focus on the state of gender and the IT labor market. In particular, we report on the key issues and themes raised by a series of in-depth interviews and an online questionnaire which were undertaken as part of our field work conducted throughout 2004.

A recent comparative survey of the IT workforce in Germany, Holland and the UK indicates that women are hemorrhaging out of the UK IT workforce. Although women are making inroads into technical and senior professions, there remains a "feminization" of lower level jobs, with a female majority in operator and clerical roles and a female minority in technical and managerial roles (Platman & Taylor, 2004).

The results of our research suggest that women often have a hard time in the IT industry, including having to accommodate a long hours culture where flexibility often means constant availability (Hoque & Noon, 2004). This culture serves to marginalize and undermine women. Our interviews with individual women in the IT industry enabled us to explore in more depth concerns raised by past and contemporary academic work, such as that of Morgan, Quesenberry, and Trauth (2004) on the existence of "Old Boy's Networks"[6] in the IT industry—we were better able to understand the organizational and socio-cultural context in which these women's experiences are embedded.

We report very briefly on some of the issues raised through our empirical work.

On What Constitutes "Working in IT"

Our interviewees and questionnaire respondents expressed job satisfaction particularly with the opportunity to combine technical skills and knowledge with "people" and communication skills. However, it is notable that these often highly technically skilled women play down their technical knowledge when talking about their work in general terms, preferring to think of their role as using technology to manage and/or help people. A striking initial feature is the vehemence of women saying "I'm not in IT but…," "I'm in sales," "I'm in the people part of the organization," "I'm a manager"—overwhelmingly "I'm not in IT."

On Being an "It" in IT

The situation of being a woman and issues of self and identity at work in male dominated IT workplaces was often discussed. As one respondent put it:

I have almost forgot that I'm a female in this business, I'm not denigrating being a woman in any way but I've almost had to push aside being a female and get on with the job like any man would do.

We argue that the ways in which women in our study distanced themselves both from IT and from their gender demonstrates that women struggle to become comfortable with gender identities in relation to IT as IT is so often related to masculine technical skill. In our study this often manifested itself in terms of a loss of confidence in the women we interviewed.

On Masculinity and Organizational Culture: Exclusion from Masculine Spaces

There is evidence of male-dominated informal social networks within the IT sector. Women felt excluded from masculine technical work in intangible ways and yet other forms of exclusion may actually be spatial in nature, in terms of women in the IT workplace being discouraged from using certain technologies, or being excluded from particular "male" spaces, as an interviewee detailed:

It took me half a year to gain access to my own training lab, because my guys considered that no girls or females should be allowed in the lab so I asked "Can I just go and see it?" and (they responded) "women are not allowed in the lab, what are you going to do there?" *I said "Excuse me there must be a difference as a manager. I must be allowed in even if it is just to look around. I'm allowed in. I'm a manager."*

GENDER AND ONLINE LEARNING

Research about Information and Communication Technologies (ICTs) in society is often set in the context of the "new orthodoxy" (Huws, 2003) using phrases such as the "era of ubiquitous computing," "information society," or "global knowledge economy." In this context from all corners of the globe, the online revolution is proclaimed. The imperative is to connect; to shop, work, learn, be governed, even fall in love online. Government initiatives proliferate globally, stressing the urgency for citizens to "engage" with ICTs. ICTs are being introduced to the teaching and learning process at an increasing pace. E-government ministers are particularly concerned about the "have-nets" and "have-nots" in this "digital revolution." Yet research in schools and the HE (Higher Education) sector looking at women learning online have indicated barriers. French and Richardson (2005) discuss how gendered relations in the home, work and education go far beyond having access to information technology (IT). They illustrate how these relations contribute to the shaping of the gendered experiences of using technology in education.

Women's overall participation in Higher Education in the UK has actually exceeded the numbers of males, yet women are choosing not to follow IT and computer science as a degree option. Women lack knowledge of IT and computing as a career and have an image of computer science as nerdy, geeky, anti-social, machine-orientated, mathematical and solitary. The finding that there are relatively few women lecturers in IT reinforces the idea that IT and computing is a male domain. If women students have to consult male lecturers, professors, and tutors every step of the way, then this gives a clear message about the world of IT and technology. Schools and universities reproduce gendered expectations about the use and capabilities of IT (Mahony & Van Toen, 1990) and computer scientists as "experts" have continued to create a "chilly climate for women" (Crawford & MacLeod, 1990).

GENDER AND HOME E-SHOPPING

Helen Richardson began this research in 1998 at the height of the dot-com boom. At the time the literature was divided. In the utopian "hyped" fantasy world, the High Street by now would have ceased to exist (De Kare-Silver, 1998). It was predicted that we would all be engaged in shopping through various media and shopping would have been transformed beyond recognition. On the other side of the spectrum, commentators suggested that e-shopping would have "no impact" (Markham, 1998) and would be an irrelevance. Of course the dot-com collapse in 1999 dented the e-shopping hype; nevertheless, the dot-com myths (Howcroft, 2001) still reappear and reinvent themselves when the next "revolutionary" media appears on the scene.

Home e-shopping though, enables consideration of engagement with ICTs in the very personal and private sphere and how technologies become embedded into everyday life. This research considers domestication of ICTs into the household—a political and contested social space (Silverstone & Hirsch, 1992) where scarce resources have to be competed for (Green & Adam, 1998).

Studies of home e-shopping need to be set in the context of cultures of consumption particularly in an "era of ubiquitous computing." We are being urged to consume and to engage with ICTs in the home. We are encouraged to use PCs in the home as an aid to study, for leisure, for electronic governance, and to e-shop, using a variety of home-based media.

Home PC ownership also has a strong association with the daily bombardment of digital divide rhetoric as well, demanding an individual commitment and responsibility to "self-help." In other words, the message is embrace the ICT "revolution" or be a victim of digital "have-not-ness" brought about, it is implied, by personal inadequacy and culpable neglect. Many people are living busy lives with an overload of domestic and work commitments in the everyday struggle to "make ends meet." Use of ICTs in the home in this context is just another thing to be dealt with.

A clear theme emerging is that household maintenance tasks are not shared equally and so there is unequal access to "spare time." Households are home to a plethora of technological gadgets associated with leisure and communication. What is absent is the leisure time to use them. Moreover, there are tensions and contradictions evident with home e-shopping where the household is also encouraged to be an arena for individualistic consumption as well as an arena for family life and relationships.

G

GENDER AND COMPUTER ETHICS

Alison Adam has been researching this area for the last five years (Adam, 2005). Computer ethics[7] research is often gender blind except for statistical studies which look at whether there are differences between men's and women's decision making in relation to computer ethics problems. Instead, a feminist approach would de-emphasize ethical decision making, looking instead to problematize gender in relation to topics such as privacy, hacking, cyberstalking, surveillance, and so on, arguing that many of these topics cannot be fully understood unless the gender dimension is analyzed. Importantly, this approach also looks to feminist ethics rather than traditional ethical approaches to emphasize care and relational networks over individual moral agents.

For instance, considering gender in relation to hacking it might be supposed that this involves the question of whether there are any women hackers. Whilst this is certainly of interest, Adam (2005) argues that there are other important issues in relation to gender and hacking. A feminist analysis of the "hacker ethic" reveals that the apparently egalitarian ethic of the hacker serves to exclude those who are not educated middle class males without family responsibilities.

CONCLUSION

In this account we have showcased the work of GRIS at the University of Salford. We intend to continue our research into many aspects of gender and information systems to shape this critical research field in our quest for transformation and emancipatory change.

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ENDNOTES

1 Feminist ethics is an alternative form of ethics inspired by feminism which emphasizes relational moral theories such as maternal ethics or an "ethics of care."

2 That is, adopting an unspoken or implicit political position which recognizes that there are inequalities but does not explore the deeper structural reasons for inequalities.

3 "IT" is meant to refer to information technologies such as computers, modems, printers, etc. The term "ICT"—information and communications technology—is the broader term and is often used to encompass network technologies. However, "IT" is the older term and many people use this term to include network technologies, even though, strictly speaking, "ICT" should be used. "IS"—information systems—encompasses the study of IT and ICT in social and organizational settings.

4 Salary secrets are the situation in many IT jobs where salaries are kept confidential—often on pain of dismissal—this conceals gender pay discrimination.

5 See the project Web sites at http://www.isi.salford.ac.uk/gris/winit and http://www.isi.salford.ac.uk/gris/winwit.

6 Old Boy's Network refers to male informal networks which serve to promote and support men in organizations and which exclude women and so act as a barrier to women's progression.

7 Computer ethics is the study of ethical problems in relation to computers and ICTs.

Social Change Research and the Gender Gap in Computer Science

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INTRODUCTION

At Carnegie Mellon University, home to one of the top computer science departments in the country, only 7% of the students in the entering computer science class in 1995 were women. By the fall of 2000, that proportion had risen to 42%. While the percentage of women entering has declined slightly, likely reflecting the bursting of the Internet bubble, Carnegie Mellon's female computer science enrollment remains at about 30%, far higher than the average among research departments of computer science. Today, in 2005, the Carnegie Mellon School of Computer Science, with its increased number of female students, is a changed place. What sparked this development?

The story of the research that served as a catalyst for these increased numbers can be found in our book *Unlocking the Clubhouse: Women in Computing* (Margolis & Fisher, 2002). In this book we lay out the blueprints—the walls, doors, and windows—of the "boys' clubhouse" of computing education. We describe some specific institutional changes, enacted both by us and by others at Carnegie Mellon, which resulted in increasing the recruitment and retention of women students. These changes range from rethinking admissions criteria; contextualizing computer science ("computing with a purpose"); paying attention to students' experiences and the department culture; accommodating a wide range of previous computing experience; recognizing that women and students who do not fit the prevailing norm are disproportionately affected by problems like poor teaching, unapproachable faculty, or hostile peers; providing students with a broader picture of what it means to be in computer science, other than the hacker stereotype; outreach to high schools; and the formation of a vibrant women's organization.

In this article we offer reflections about some of the critical factors that contributed to our research becoming an instrument for social change. We provide some "lessons learned" for other institutions that are thinking about addressing the gender gap in their computer science departments. While the Carnegie Mellon developments began with a body of research, we do not believe that extensive research is necessary for all institutions. However, it is important to understand the local situation well enough to customize a general set of strategies. While people rightfully want to learn from successful initiatives, and not "reinvent the wheel," the constitution of each department—its history, the culture, the demographics, the leadership, the pressure points, what is known and not known about the experiences for women students—will differ from institution to institution. In most cases, but not all, initiatives can be modeled after existing programs by understanding the commonalties and differences between the situations. To achieve this, some straightforward data gathering, as opposed to in-depth research, is usually called for.

Here we present brief summaries of "lessons learned" from our research on the gender gap in computing. We believe that what we learned applies to planning an intervention as well as to conducting research.

ADDRESSING THE PROBLEM

- **Understand Your System and Know Your Numbers:** While lessons from other settings and other "diversity projects" can be instructive, the critical question is how this all applies to your own institution. The management truism that "you can't improve what you do not measure" applies here. Where is the bottleneck in your department? Is it in admissions? Is it in retention? When are people being lost? How many women students are in the department? How many women faculty? How does this compare to other technical departments in your institution? What are the retention rates of women in computer science? What have the trends been? What is the culture of your department? How do women experience the department? And, where are the relevant points of intervention within your department?

Local information is also critical to community engagement. While information about the gender gap from other places can be imported, especially when you have a "convinced audience," there is nothing like shining the light on your own backyard, and providing evidence from your own students, to make an institutional community take notice. The Carnegie Mellon research was based on some 300 Carnegie Mellon student interviews, over a 4-year period of time with a core sample group of 50 male and 50 female computer science students. We also conducted observations of computer science classes, and held interviews with computer science administrators and faculty. We lived in the department (Allan as Associate Dean of Undergraduate Education and Jane as Visiting Research Scientist) and were familiar with it from the inside.

- **Leverage Interdisciplinary Expertise:** Our research was conducted by an interdisciplinary team. Jane is a qualitative researcher with a background in Education and Women's Studies. Allan is a computer scientist and at the time of our research was Associate Dean of Undergraduate Education in the Carnegie Mellon School of Computer Science. While we originally referred to our research partnership as an "insider-outsider" collaboration (with Allan as the insider and Jane as the outsider), we quickly realized that since we were studying the dynamics of the gender gap in computer science, both perspectives were at the core of the problem. Neither perspective was on the margins. Each of us had a key to the puzzle that the other lacked. This both equalized our collaboration and opened up the range of issues that could be investigated. Our collaboration explored the traditionally unspoken issues that impact women's experiences such as confidence, sense of belonging, and different male and female motivations for studying computer science.
- **Listen to Students Holistically:** It was students' experiences (and our eagerness to hear from women's perspectives) that led us to the trouble spots in the department. But, to learn about those experiences we had to construct an interview guide that allowed us to learn more than the "party line," and more than what was "safe" to talk about. We also needed to construct a process that allowed interviewees, speaking in confidence to third parties, to talk about topics not commonly discussed in computer science culture. Open-ended questions that encourage interviewees to describe and shape their own accounts of their experiences (such as "Can you tell me the story of you and computers?" or "Can you tell me about your decision to major in computer science?"), rather than choosing amongst pre-selected generic answers, were critical to this process.
- **Take the Long View vs. a Single Snapshot:** We conducted multiple interviews with our sample of students, following some students over a four-year period of time. This longitudinal approach allowed us to take more than just a single snapshot of students' experiences. The multiple interviews allowed us to observe the evolution of students' relationship to computing. At any point along the way had we drawn premature conclusions about the student, we would have an incomplete and misleading story. We learned that we cannot think in terms of a static set of influences on students' experiences but rather must understand students' stories in terms of a web of influences and a sequence of turning points, at each of which a different set of factors may be critical. These webs of influence were only apparent over time. Long term funding from the Alfred P. Sloan Foundation made this possible, and senior faculty member Lenore Blum

and Carol Frieze have been able to use other sources of support to investigate ongoing cultural changes within the department since. We emphasize again, though, that large-scale research is not required for effective interventions—but tracking the numbers is.

- **Understand the Dynamics:** One of our interview questions was: "Can you describe your fellow computer science students?" Male and female students gave similar descriptions of their colleagues: myopically obsessed, living and breathing computers 24/7, emerging occasionally from behind the computer with a "monitor tan." Students' responses to this "geek mythology" were interesting. Despite the fact that both male and female students had similar descriptions of their fellow computer science students, about two thirds of the women and one third of the men explicitly dissociated themselves from the stereotype: "But that's not me." Yet the widely held perception of computer science students as being interested in nothing but computing became a set of expectations against which students judged themselves. Listening to the students tell of their experiences, we heard how each student's self-evaluation becomes a critical part of his or her sense of belonging in computer science. We heard how the obsessed computer whiz kids became the reference group—a frame of reference for each student's self-assessment. As a result, some students felt a good fit between their preferences and this model of what it is like to be a computer science student and others did not. Women fell disproportionately into this latter category.

  We then saw how this sense of being outside of the norm makes women students especially vulnerable to other injuries such as poor teaching, inhospitable learning environments, and unhelpful instructors. When compounded by feeling outside the norm, seemingly small and sometimes unintended slights often are magnified. All of these chip away at a student's confidence. This, in turn, often leads to a loss of interest in the discipline. We saw once-enthusiastic students, mostly female, in a descending spiral of eroding interest and confidence, driven by negative comparisons to peers and by a variety of environmental insults.

  One key observation on these influences is something that we have come to view almost as the First Law of Educational Diversity: in a situation with in-groups and out-groups, "everything bad happens worse" for the members of the out-groups. Because of doubts about fit, comparisons with members of the in-groups, and the feedback between confidence and interest, bumps in the road—poor teaching, lack of advising, weed-out experiences, and so forth—disproportionately create disaffection and attrition among the out-groups. Note that a corollary of this observation is that many effective interventions in favor of diversity are good for *all* students.

SHAPING A RESPONSE

- **Make a Leadership Commitment:** Because the initial impetus for this project came from Allan, who was an "insider" with authority over the undergraduate program, there was an unusual level of legitimacy associated with this research. It has been all too common for gender investigations to be marginalized and not taken seriously. Because of Allan's position in the department and the fact that the project was part of the department (with a department office and a title granted to Jane as Visiting Research Scientist), a legitimacy was bestowed on the project that we believe helped facilitate information gathering and cooperation from different members of the community. This commitment was continued after our departure from the scene by Lenore Blum, who has had extensive experience in gender projects, and Peter Lee, Allan's successor as Associate Dean, with support from University leaders as well.
- **Focus on the Bottlenecks:** At Carnegie Mellon, we were "losing women" in two main ways: at admission time, where all three of application, acceptance, and matriculation rates were lower for women than for men; and in the early years of the curriculum, where nega-

tive experiences and a sense of "lack of fit" created disproportionate attrition among women. In other settings we have seen, introductory courses, processes for choosing one's major, and "weed-out" courses have posed bottlenecks. We believe it is critical to monitor such bottlenecks over time, and to focus interventions there.

- **Attend to the Basics:** A few powerful heuristics apply to almost all settings. Programs should provide mentoring and community, multiple pathways into the curriculum for students with differing levels of experience, a high-quality and positive learning environment, and should develop a culture that supports and celebrates multiple approaches to the study of computer science.
- **Paint a Broad Picture of Computer Science:** Most CS faculty think of computer science as a dynamic, multi-disciplinary field that combines aspects of mathematics, engineering and science and has application in nearly every field of human endeavor. However, many prospective students, including some of the most enthusiastic, inherit from high school and society a narrow notion of computer science as focused on computers and on coding. Addressing this ongoing legacy is a key challenge for the computing community. Further, the introductory sequences of traditional curricula often reinforce narrow images of the field, by focusing primarily on equipping students with the programming tools they will use in later, more diverse courses. Carnegie Mellon's response to this issue has included the addition of an "immigration course" introducing new students to the breadth of the field. Other institutions have developed introductory courses that use integrative projects, that focus on principles over programming, or that link computer science to applications, to help to broaden students' vision.
- **Catalyze and Support Women's Community:** Upon her arrival at Carnegie Mellon in 1999, Lenore Blum led the creation of Women@SCS, an organized group of women in computer science. A professional group like this plays several important roles. Perhaps foremost, it provides an environment for women to experience being female computer scientists together with others, without feeling the need to "learn to speak 'boy'" (as eloquently phrased by Anita Borg) in order to be in the field. In this vein, it provides a venue both for professional development experiences and for mutual support. The most successful instances of such groups seem to combine substantial student leadership with ongoing faculty support.

  Beyond its direct impact on its membership, a women's group increases the visibility and influence of women in the larger community. At Carnegie Mellon, the women's group has developed representation on standing committees, has organized events for the entire community, and has developed a variety of recruiting and outreach activities—even assisting in the creation of women's groups at other institutions.

SUSTAINING PROGRESS

- **Leverage Critical Mass and "Virtuous Cycles":** At Carnegie Mellon, changes in admission policy (removing previous computing experience as a preference factor, and emphasizing leadership potential in addition to numeric predictors) were an important factor leading to the increased enrollment of women. With more women classmates, female students no longer felt as isolated. And, as these talented and able women students had more of a presence in the department, faculty and administrators began to recognize how the increasing numbers of women in the program made the program even stronger and enhanced its competitive advantage. This, in turn, helped to make the environment ever more appealing to women students.
- **Watch the Student Experience Like a Hawk:** In most academic settings, especially in large institutions, key interactions with students are factored across multiple organizations: admissions, academics, student affairs, housing, career counseling, and so forth. Each of these areas presents opportunities to foster or weaken a student's affiliation with a discipline. We believe it is critical to work cross-

functionally both to provide students with positive experiences and to head off the oversights that can miss such opportunities or, worse yet, drive students away. While Carnegie Mellon's reputation and recruiting power played a key role in the rapid increase in the involvement of women in computing, we believe that the university's culture of working across organizational boundaries was also an essential factor; at various times, we were able to work closely with admissions staff, other colleges, the student affairs office, and others to address specific issues.

- **Adapt:** Especially in a field like computing, with its rapid technological change and dynamic business cycle, change is a constant. The students whom we first studied were among the first generation to grow up with personal computers as a pervasive presence in the home; ten years later, a new generation has grown up with the Internet and all it implies. Ten years ago we saw the first inklings of the Internet boom, and now we have been through boom, bust, and consolidation. As we write this, perhaps the key human resource challenge to the discipline of computing in the developed countries is the public perception that "all the computing jobs are going offshore" to the developing world.

  Just as the external environment changes, communities change. Lenore Blum and Carol Frieze have observed a shift in the Carnegie Mellon computer science student culture, in which both men and women are likely to take a broad and connected view of the field, and in which the traditional gender stereotypes of computing are largely defused. In light of internal and external changes, it is necessary to adapt dynamically to new sources of challenge and advantage.

CONCLUSION

Our research challenges the assumptions we often heard (and still hear): that women are less suited than men to do computer science, or that the subject is "just boring" for women and girls. Instead, our research shows the weighty institutional influences that steal women's interests in computer science away from them. It is critical to recognize the "First Law" effect, that women and other students who do not fit the prevailing norm are disproportionately affected by problems within the "computer science pipeline."

The goal should not be to fit women into computer science as it is usually conceived and taught. Instead, as we suggest in *Unlocking the Clubhouse*, "a cultural and curricular revolution is required to change [the culture of] computer science so that the valuable contributions and perspectives of women are respected within the discipline." Ultimately, this revolution serves not only the interests of the women involved, but those of the discipline itself.

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Section II:
Gender and Information Technology General Content

Access and Use of ICTs Among Women in Jamaica

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A

INTRODUCTION

Information and communication technologies (ICTs) have made the global village a reality with the Internet, cell phones and other digital communication technology disseminating messages instantly through the fast information superhighway. The United Nations (U.N.) Development Program (UNDP, 2001) defines ICTs in terms of innovations in microelectronics, computing (hardware and software), telecommunications and opto-electronics—micro-processors, semiconductors and fibre optics. These technologies enable the processing and storage of enormous amounts and rapid distribution of information through communications networks. As new innovations, ICTs are also described as "the building blocks of the networked world," (UNDP, 2001, p. 30), with ICTs, particularly the Internet, being used by a variety of organizations as a global networking tool.

Access to, knowledge of and effective use of ICTs is crucial, particularly where access to the technology is equated to social, political, economic and human development. Internet usage, for example, is regarded as the standard indicator of the use of ICTs and also the most democratic of all mass media, mainly because of their low investment (Internet World Stats, 2006). This technology has been used effectively as a tool for delivery of various services and applications, including distance learning, agriculture, telehealth, e-commerce and e-governance. Individuals, organizations and institutions now use the Internet to strategically reach a large audience of markets through e-mails and other advertising strategies, since it is fast and economical, irrespective of size or location of business.

There are many gender issues, however, related to connectivity and access to available ICTs, some of which are visibly documented and most often examined as the digital divide based on gender. Rakow (1986), in her classic studies on gender and ICTs, however, points out that technology should not be examined based on the differences in the behavior of men or women towards a technology, but instead to look for the ways in which the technology is used to construct us as women and men through the social practices that put it to use. Rakow further argues that more attention needs to be paid to how communication technologies alter, aid, or construct women's opportunities for interacting with each other and with the wider public domain.

This article is based on data gathered through a detailed open-ended questionnaire, with a sample of 121 Jamaican women, ages 21 and older, and explores their access and nature of use of ICTs as well as challenges they face in their attempts to use them effectively. Like other Caribbean islands, Jamaica has embraced ICTs as a tool for national development, adopting the most recent technologies to ensure global connectivity. The study examines how these technologies could be used effectively to address some of the developmental, economical, health and human developmental challenges that face the Small Island Developing States (SIDS). These findings are used to complement existing studies, including national surveys and literature on the gender and ICT issues in the Caribbean.

BACKGROUND

Gender analysis has been applied to virtually every social, economic, political and environmental field of study, including communication technology. The latter is an area of research that has attracted interest among researchers, scholars, practitioners and policy-makers from various disciplines. Over the years, such interests have ranged from the "social shaping of technology" tradition (MacKenzie & Wajcman, 1999) to gender involvement in production and use of technologies (Henwood & Hart, 2003; Robins, 2002; Shade, 2002, 2003). These studies have questioned the existing gender imbalances in ICT access and use while at the same time recognizing the possibilities that technologies allow for gender equity and empowerment (Cooks & Isgro, 2003).

Gender equality is integral to a human rights-based approach to development (Hafkin & Odame, 2002) and for sustainable development. Since the early 1990s, ICTs have been pushed as a tool for women's empowerment and development, but the effort heightened by the U.N. declaration of the Millennium Development Goals (MDGs). Goal 3 focuses on gender equality and empowerment of women as a contributor to "free out fellow men, women and children from the abject and dehumanization conditions of extreme poverty" by 2015 (UNDP, 2005). This is done through advocating and supporting active participation of women in development while recognizing their triple role in production, reproduction and community work.

Today, a vast majority of women in developing countries use ICTs for information dissemination and retrieval, while others, mostly women's organizations, use the technology to network with other agencies in their area of operation; search for grants and other support from the international community; and promote their activities online. In Latin America and the Caribbean, there has been a felt need for gender and development through access and effective use of ICTs. One of the most successful information networks for women is in Latin America, where a gender and ICT project was initiated following an urgent need for news with a gender perspective. As a result of this need, a feminist activist in Mexico, who felt the lack of communication and the need to link women's organizations nationwide, launched the creation of an electronic communication network with minimal infrastructure and some previous training in e-mail. With a group of women they started the *Mademmujer*, an information and communication network that aimed to strengthen women's participation (Plou, 2003).

When ICTs are accessible, affordable and designed to support specific needs for analysis, storing and exchanging information, they can enable people in all sectors of society to accomplish tasks that otherwise would be too costly or impossible (Commonwealth, 2001). Several other organizations worldwide recognize that the benefits of public recognition for concerns that have been private and hidden can provide for women in contexts that would otherwise have remained peripheral or invisible.

The Jamaican ICT Situation

ICTs have been adapted in the Caribbean to a great extent within the government ministries, non-government organizations(NGOs) and the private sector, a trend that was exacerbated in the wake of the 2001 World Summit on the Information Society (WSIS). The summit facilitated the creation of an environment through which the full power of ICTs can be brought to bear on the issue of development to the benefit of all. The government of Jamaica, for example, has made the integration of information technology (IT) into the economy a high priority and a strategic imperative, thus facilitating the diffusion process. The Ministry of Commerce spearheaded this effort by having recently added "Technology" to its name to read Ministry of Commerce, Science and Technology (MCST).

Diffusion of ICTs in Jamaica has taken several approaches, but the most visible is the training efforts by government and academic institutions. Two government-supported institutions—the HEART Trust and National Training Agency—offer a range of critical skills necessary to compete in the labor market. Courses offered include MS Office; basic and intermediate IT; call center; worker training, including data entry; networks; and programming, in concert with the Caribbean Institute of Technology. These programs have had about 70% female enrollment since 1999 (Francis-Brown, 2003). At the tertiary level, the University of the West Indies has played a leading role in IT training along with the neighboring University of Technology. The Caribbean Institute of Media and Communication (CARIMAC), with 90% of female students enrollment, has a stronger focus in ICT training, offering undergraduate and graduate courses in effective use of the technology while enabling access to the technology for institutional affiliates. The graduate program, Masters in Communication for Social and Behavior Change (CSBC), launched in 2004, for instance, provides laptop computers with wireless Internet connection to participants as part of the package while the University installs hotspots on various parts of campus. Providing access to online resources and connectivity has triggered the interest and possibility of developing and offering online courses, even with limited human resources.

Women's Access to ICTs

Like the wider Caribbean, the majority of women in Jamaica have access to the most common communication technologies. Though this was a small study, findings indicate that the ICT adoption situation in Jamaica is impressive, with more than 80% of women interviewed having access to a variety of common ICTs—Internet access (81%), cell phones (99%), cable/digital TV (83%) and radio (98%), among others. The finding on Internet access is in line with the national study by the Market Research Services Ltd. (MRSL) commissioned by Jamaica Promotions Corporation (JAMPRO), which found a universal 91% awareness of the Internet among Jamaicans 15+ years. That study sought to establish current awareness and usage of the Internet, attitudes and intention to use it, and found that close to 70% of those aware of the Internet had used the Internet and the remaining 30% had an intention to use it within a short term or as soon as they gained that access.

Mobile phones have also become a permanent feature in everyday communication for women in Jamaica and the wider Caribbean. This is visibly so where prepaid mobile phones are overwhelmingly accessible to literally everyone who can afford a minimum about United States (U.S.) $25 with free activation and no signed contracts or other commitment to the provider. Making calls using a mobile phone within and outside of the Caribbean is the most inexpensive way to keep in touch, especially with free incoming calls. About 49% do text messaging, another form of affordable communication, and 3% access the Internet, while 21% play games on their phones. This, however, varies with age, where older women use their phones exclusively for making calls.

With regard to Internet access, about 98% of women in Jamaica have access to the Internet, which implies access to computers and at various locations, including home (61%), work (33%), school (15%) and other places, like the post office, public library, and friends' houses. A small minority (9%) have access at Internet cafés and a negligible 3% through their mobile phones. This small percentage is directly related to the high cost involved accessing the Internet at the cafés and via mobile phones, but one respondent noted, "Some young people use their phones to get 'blue movies,' [meaning accessing pornographic sites] and to download pictures for their phones' screens as screen savers." The Internet cafés were also not very popular with women, due to their location. Some women who had to take public transportation feared the risk of molestation either in the buses or the cafés, a major limitation for women with no access elsewhere.

Main reasons that women went online included checking e-mails (78%) and information gathering or research (74%). This included Web surfing, participating in newsgroups and other listservs. They accessed gender- and health-related information, such as chronic diseases, obesity and weight loss, mental health, cancer; and reproductive health topics, such as sexually transmitted diseases including HIV/AIDS, which has become a woman's disease affecting more Caribbean women and girls than men. Gender-based violence, a regional problem requiring multisectoral attention, is another issue that organizations such as Women's Media Watch, Sistren Theatre Collective, Crisis Center, Bureau of Women's Affairs, Woman Inc. and Fathers Inc., among others, address. The organizations go online to learn about strategies applied by other women's organizations globally and to network with others addressing the same issues.

FUTURE TRENDS

Given the current ICT situation in Jamaica and available infrastructure and support from the Caribbean governments, there is much to look forward to in the application and use of the technology as tools for human development and gender empowerment. There are limited or no problems in relation to mobile phone use as more service providers emerge in the region. Their cost effectiveness and convenience has led to their replacement of land lines in some homes, though 80% use that form of communication in addition to mobile phones. This wide access and use of this technology has prompted researchers to explore ways in which this technology could be used effectively to address some gender and development issues in the Caribbean. Health and gender organizations are currently exploring how information could be effectively disseminated to women and the wider population through mobile phones. This, however, requires ICT policy development and guidelines for such use. It is observed that policies are made to increase access and use of ICTs at various levels as a strategy for gender empowerment and capacity building without any regard for the social and cultural needs among women or other disempowered groups (Wajcman, 1995).

There are also challenges associated with Internet access and use among women, including lack of computers (51%), lack of training (56%) and lack of Internet connection (41%). The availability of land lines and monthly costs for Internet connection (at least US$35 per month) limit connectivity, and only a very few people island-wide have wireless connection. The broadband connection is gradually venturing into the Island, but costs are prohibitive for the majority of the Jamaican population. Other challenges include social, cultural and policy factors in training and other gender biases in ICT application use, ownership and other gender biases. This affects the level and type of IT training that women receive, where men become techno-savvy while women assume less-skilled ICT-related responsibilities and, therefore, less compensation. Observations indicate that as soon as the new technology starts to produce income, it is often taken over by men (Paris, Feldstein & Duron, 2001). However, women have recognized the need for training as a ticket to self-empowerment, competence and self-efficacy.

Many programs in Jamaica attempt to empower women in use of technologies in the region, but more needs to be done in providing access at various levels. The University of the West Indies has set a good example for other academic institutions through provision of laptop computers, a trend that others must follow. The Caribbean governments have also taken training and gender inclusion into consideration, establishing training institutions and other support for women (Muturi, 2005), thus playing a role toward the achievement of the MDGs. Similarly, some NGOs have realized the potential for ICTs in addressing gender-related issues, facing them through effectively using the Internet as a tool for networking and information dissemination and facilitating change among women and other stakeholders. The Women's Media Watch, for example, has taken the responsibility to support the training of its members, offering basic IT courses to willing participants, and continues to use the Internet for networking with members locally and abroad. Recently, the organization started an online newsletter, sharing information with its members and sponsors on current projects and activities in Jamaica.

CONCLUSION

It is now acceptable globally that women's participation in development is crucial, but they need to have the necessary IT skills and education for competence in a male-dominated field. Though the majority of organizations use the Internet for information dissemination, limited studies assess communication efficiency and effectiveness of the current strategies particularly targeted for women. Mobile phones, on the other hand, are easily accessible to every woman, but many Jamaican organizations have not explored their potential as a tool for achieving their development goals, reaching their target audience directly with information and at their own time and space. This, however, requires a larger study, to explore how these technologies could be effectively used to address developmental challenges such as poverty, gender disempowerment and several vulnerabilities facing the SIDS, including natural disasters such as hurricanes, tsunamis and earthquakes but with more serious consequences among women.

Gender-sensitive policies need to address the major women's concerns, including social, cultural, economic and political factors, and security issues that deter their active participation in ICT access and effective use. This article underscores the fact that such factors are unique to every country and society, and Jamaica is no exception; but research in this area is inadequate. It must be recognized that even with the global diffusion of ICTs and their applications, access to some technologies in the low-income countries is still limited and requires more attention.

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KEY TERMS

Diffusion: The adoption and implementation of certain innovations, products, services or practices that have been promoted and found effective in achieving certain goals. Application and effective use of communication technologies among women has been viewed as one strategy for achieving human development goals through gender equity and empowerment of women.

Empowerment: Term commonly used in the area of gender and development referring to provision of skills, access to information and ability to make choices, and self-efficacy and self-esteem. Gender empowerment enables men and women to have equal opportunities and to participate in activities that contribute to human development.

Gender: Society's construction of femininity and masculinity. Gender to some extent determines access and use of technologies and gender roles in relation to ICTs.

Human Development: As defined by the United Nations, it is about an environment in which people can develop their full potential and lead productive, creative lives in accord with their needs and interests. Human development considers that people are the real wealth of nations and promotes investing in them through enlarging their choices for all other forms of development.

Information Communication Technologies (ICTs): All forms of development, processing, storage and dissemination of information to a target audience in an effective and strategic manner, aimed at achieving certain communication goals.

Innovations: Any idea, product or service significantly improved or viewed as new to the target audience that it is intended for. ICTs, including mobile phones, computers and other communication technologies, are considered as communication channels as tools for development and gender empowerment.

Millennium Development Goals (MDGs): Set by the United Nations to contribute to the reduction of global poverty by 2015. These goals include: eradicating extreme poverty, providing universal primary education, combating HIV/AIDS and malaria, promoting gender equality and women empowerment, reducing child mortality, improving mental health, ensuring environmental sustainability and developing global partnership for development.

Small Island Developing States (SIDS): Small countries located in the small islands of Africa, Asia and the Caribbean and other low-lying coastal regions. These states are vulnerable to several natural disasters and challenges of developing countries due to their physical size, geographical locations and archipelagic formations. Through ICTs, various agencies have addressed these challenges.

ACM's Attention to Women in IT

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INTRODUCTION

The Association for Computing Machinery (ACM) is a major force in advancing the skills of information-technology professionals and students worldwide. It was founded in 1947, and today has about 80,000 members. This article summarizes how this organization views the issue of women's participation in the hi-tech field. As it turns out, though the topic is addressed extensively in the association's newsletters and reports, women representation in these fields remains low.

BACKGROUND

This article reviews *ACM TechNews*, an e-mail newsletter that provides timely information to IT professionals 3 times a week and is directed toward the wider membership of the ACM, one of the larger associations of people working in the computing fields. Each message sent to the list consists of about 10 to 15 short news items based on articles published in various hi-tech and computing magazines and journals. The short messages refer interested readers to the full articles.

We found it interesting to survey the news published in the messages sent to this list since the items are selected from the vast body of material published in the computing field according to their relevance to the majority of the community. Thus, news published in these digests reflect, in a way, the issues this community is concerned with and conceives as important.

As it turns out, the ACM community finds the topic of women in the computing fields to be highly interesting. During the past 5 and a half years (January 2000 through May 2005), 164 messages out of some 850 that were sent to the list contained a news item related to women. For illustration, during the first 4 months of 2005, 22 messages out of 43 messages sent to the list included a news item about women. This picture clearly indicates that this community finds the topic of women in the IT fields interesting. However, as we illustrate later, most of the news address, from different perspectives, the underrepresentation of women in the IT fields.

MAIN THRUST OF THE ARTICLE

This section presents the picture revealed from our review of *ACM TechNews*. Here is one example, taken from the April 20, 2005, newsletter, of how a news item appears on the list. Out of 19 news items, the 15th item was the following one.

- **What IT Women Want:** *A virtual roundtable of successful businesswomen moderated by Kathleen Melymuka discussed the challenges faced by women in IT and what recruiters and employers should do to attract and retain them. Scites Associates President Jan Scites said "the fundamental issue for women is that very few ..". [read more]*

The "read more" link refers the reader to an expansion of this short description, in this case to http://www.acm.org/technews/articles/2005-7/0420w.html#item16.

At the end of the expanded description, there is a link (indicated by the phrase "Click Here to View Full Article") to the original article, which in this case is located at http://www.computerworld.com/careertopics/careers/story/0,10801,101088,00.html. News items that address women in the IT professions also include the following note: "For information on ACM's Committee on Women in Computing, visit http://www.acm.org/women."

In what follows, we survey the central women-related topics of news items that appeared in the *ACM TechNews* newsletters. We also add our perspective on these issues. The URLs (uniform resource locators) that refer to the ACM newsletters are presented in the footnote, and the full reference appears in the reference list.

As hinted previously, one of the main issues addressed in the ACM news digest with respect to women in IT is their low representation in the field. According to the Commission on Technology, Gender, and Teacher Education, the female portion in the IT workforce in the United States has shrunk from 40% to 20% in the last 15 years (Raimy, 2002).[1] This phenomenon is called the "shrinking pipeline" (Camp, 1997).

Similar findings were presented by the U.S. Bureau of Labor Statistics (Clements, 2002).[2] In 2003, women accounted for half of the workforce in the United States, but for only 20 to 25% of the technology professionals in that country (McCarthy, 2003).[3] A more recent report from the Information Technology Association of America shows a severe decline in the percentage of women in the IT workforce. Women held just 32.4% of IT jobs in 2004 in general, a proportion that represents a 41% drop since 1996 (Wong, 2005).[4] To summarize, in IT fields, the percentage of women fell by about half between 1985 and 1995 to just 20% (Kimberly, 2005).[5]

Although women hold about 20% percent of all IT positions, reports the American Association of University Women[7], only few women hold upper level management positions. Liz Ryan, executive director of WorldWIT (Women in Technology), an international Listserv for women in the IT field, says women still confront a "slow, uphill climb" in the industry. She says the dot-com culture was a step backward for women in some ways because of the mentality that reigned at many dot-com startups (Solomon, 2000).[6] Women working their way up through the IT ranks must struggle with gender bias, cultural stereotypes, and male misconceptions that women know less about IT than men (Hogan, 2001).[8]

Different reasons are presented as explanations for the low representation of women in the IT workforce. Here are three of them.

- **Stereotype:** It has been suggested that the low representation of women in IT results from the "geeky" image of IT workers that discourages women from pursuing tech careers (Ascierto, 2003).[9] Different attempts worldwide made to attract more women to the IT industry show that the field offers creative careers that provide social interaction and make a difference in the real world. This approach is based on the assumption that women prefer professions that involve human interaction.
- **Male Dominance of the Culture and of Networking, and the Need to Adjust to This Culture:** It is sometimes argued that the IT field is a male-dominated computing culture, and that extroversion and the unabashed promotion of one's own accomplishments are signs of intelligence, whereas the low-key, self-effacing approach that women tend to use indicates a lack of achievement (Applewhite, 2002).[10] In order to succeed and gain credibility in such an environment, women must sometimes engage in male-oriented activities (Messmer, 2003).[11] It is suggested that the agile approach toward software development (Cockbum, 2001), which recently got a lot of attention in the software industry and is largely based on communication and teamwork, may fit to women's working and management style (Hazzan & Dubinsky, in press).
- **Family-Career Conflict:** Women sometimes find it too difficult to juggle work and family (Czetli, 2003).[12] This idea is illustrated in another contribution to this encyclopedia (Hazzan & Levy, in press). In that article, we present the perspective of female software engineers in the Israeli hi-tech industry by describing six typical profiles that emerge from the analysis of our data. One reoccurring theme related to all these profiles is the family-career conflict.

In addition to the decline in the overall numbers of women in the IT fields, the ACM community discusses through its *TechNews* publication other gender-related issues. Here, we mention three topics that are frequently addressed in the ACM digest: exit rates, executive positions, and salaries. Then we highlight the topics from an international perspective and address women's skills with respect to the IT field.

Exit Rates

A survey conducted in 2001 by GLS Consulting revealed that 41% of the 265 IT women surveyed were considering leaving their positions due to the stress of balancing their work with their personal lives. Sixty-five percent said that working in the IT field has had a negative impact on their personal lives (Melymuka, 2001b).[13] The exit rate is expressed in our above-mentioned article in this encyclopedia (Hazzan & Levy, in press) by one specific profile of female software engineers. This profile describes female software engineers who leave the hi-tech industry at different stages after they become mothers. According to Armstrong (2005),[14] when women leave the IT workforce, the IT industry loses, among other things, sheer talent, women's collaboration skills, and their very different way of looking at problems. For example, Armstrong indicates that research suggests that women see more nuances and have a more holistic approach than men, who are more linear thinkers. She says, "Without both kinds of thinking, you lose the breadth of perspective that can approach a problem from multiple directions, resulting in creative solutions otherwise unavailable."

Executive Positions

According to statistics offered by the nonprofit research group Catalyst,[15] women account for only 8.1% of executives at major hi-tech firms, compared with 12% at major companies across all industries, and many women who reach the upper level of management hold nontechnical positions in human resources, marketing, and sales. Indeed, according to a survey of 1,000 women and 500 men employed in the IT industry, 62% of women said a glass ceiling exists in the IT industry; 62% of men said there is no glass ceiling. When asked if too few women have IT leadership positions, 84% of women said yes, and 57% of men agreed. However, while 75% of men said there is gender equality in the IT industry, only 56% of women agreed (Melymuka, 2001c).[16] Still, according to the U.S. Bureau of Labor Statistics, in 2003, men held 69% of the 347,000 computer and information-systems manager jobs in the United States (Brown, 2004).[17]

Salaries

According to the results of InformationWeek Research's 2002 National IT Salary Survey, the salary gap between male and female IT professionals appears to be widening. In terms of total compensation, men are making about $7,000 a year more than women. Female IT managers earn $10,000 less median total cash compensation than their male counterparts (Goodridge, 2002).[18] According to a survey conducted by the Standard, women working in the Internet industry earn significantly less than men, even when adjustments are made for education, industry, and job title. The survey, given to some 2,600 newsletter subscribers, found that women in the Internet industry earn a median base salary of $60,500, compared with $80,000 earned by their male counterparts. Meanwhile, women receive a median bonus of $7,000, which is less than half of the $15,000 median bonus awarded to men. Women responding to the Standard's survey worked 9.7 hours a day on average, while men worked 10.3 hours. In addition, slightly more than half of the women worked at least one weekend per month, compared with 61% of the men (Carr, 2001).[19]

While the above data refers mainly to the United States, the low participation of women in the IT fields is well known in many other places in the world as well. Following are two examples.

- *The number of female network professionals in Western Europe is expected to double by 2004, although they will still comprise only a small portion of the employee population, concludes an IDC report for Cisco Systems ... Out of 13 countries surveyed by IDC, France is expected to have more women in the networking industry than any other country; the participation rate is forecast to reach over 12 percent by 2004.* (Mayfield, 2001)[20]
- *In the United Kingdom, although 36% of new hires in the first quarter of 2002 were female, women represented 46% of all those leaving the field. Some women are quitting*

their careers to focus on family life, but older women are leaving as well (Fielding, 2003).[21]

The underrepresentation of women in the IT field presented above contrasts the fact that women have the needed skills for this industry and that this industry does need women. For example, it is argued that "[t]he IT industry, e-business in particular, is considered to be a more favorable working environment for women than old economy corporate America" (Vaas, 2000).[22] Furthermore, according to Irene Dec, vice president for International Investments at Prudential Financial, women possess the soft skills needed to succeed in global IT initiatives. She says, "You need people who can collaborate, build relationships, understand behavior, and women tend to be more in that play." Specifically, these people have good listening skills, socialize readily, follow other people's behavioral cues, study up on the local culture, and are patient and respectful. Indeed, soft skills alone are not enough; women must also possess knowledge and expertise to establish their value (Melymuka, 2001a).[23] With respect to management, it is believed that women make ideal managers in tech organizations based on the strength of their communication, social skills, relationship management, team building, and multitasking (King, 2004).[24] As has been mentioned above, it seems that the agile approach toward software development fits these traits of women, and may partially help in expanding the shrinking pipeline (Hazzan & Dubinsky, in press).

FUTURE TRENDS

This article illustrates the gap between the attention a topic receives and its low impact on the field. More specifically, on the one hand, the ACM news digest discusses the topic of women in IT quite extensively, yet on the other hand, the representation of women in IT remains low. This situation raises questions such as what are the roles of the associations that are supposed to deal with this issue? How can this situation be changed? How can such a discussion increase the representation of women in the IT industry? These questions are important, especially in the case of the ACM since the organization boasts a designated chapter called ACM's Committee on Women in Computing, which is described on the organization's Web site (http://www.acm.org/women) as follows: "ACM-W is the ACM committee on Women in Computing. It celebrates, informs and supports women in computing, and works with the ACM-W community of computer scientists, educators, employers and policy makers to improve working and learning environments for women."

CONCLUSION

The ACM news digest is only one mailing list surveyed for the purpose of this article. We conclude with an invitation to survey how the issue of women in the IT fields is manifested in other similar lists and forums in other places on the globe.

ACKNOWLEDGMENTS

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KEY TERMS

ACM TechNews: *ACM TechNews* is a comprehensive news-gathering service, published 3 times a week, that scans the headlines to bring topics of interest to the IT professional via e-mail. *ACM TechNews* is available to everyone: members and nonmembers. ACM members receive an e-mail alerting them to the table of contents as a benefit of membership. (http://www.acm.org/technews/)

Association for Computing Machinery (ACM): Founded in 1947, ACM is one of the major forces in advancing the skills of information-technology professionals and students worldwide. The association's 80,000 members and the general public turn to ACM's portal to computing literature, authoritative publications, and pioneering conferences. (http://www.acm.org/)

Shrinking Pipeline: The pipeline represents the ratio of women involved in computer science from high school to graduate school. The pipeline shrinkage problem focuses on several critical junctions: from high school to the bachelor's level, and at the seniority levels both in academia and in industry.

ENDNOTES

1 Posted on April 3, 2002: http://www.acm.org/technews/articles/2002-4/0403w.html#item15

2 Posted on August 5, 2002: http://www.acm.org/technews/articles/2002-4/0805m.html#item3

3 Posted on March 21, 2003: http://www.acm.org/technews/articles/2003-5/0321f.html#item3

4 Posted on June 22, 2005: http://www.acm.org/technews/articles/2005-7/0622w.html#item2

5 Posted on March 25, 2005: http://www.acm.org/technews/articles/2005-7/0328m.html#item2

6 Source, November 27, 2000: http://www.computerworld.com/cwi/story/0,1199,NAV47_STO54319,00.html

[7] Source: http://www.aauw.org

[8] Source, September 15, 2001: http://www.cio.com/archive/091501/women.html

[9] Posted on September 29, 2003: http://www.acm.org/technews/articles/2003-5/0929m.html#item7

[10] Source, April 30, 2002: http://www.spect rum.ieee.org/WEBONLY/resource/may02/care.html

[11] Posted on September 29, 2003: http://www.nwfusion.com/news/2003/0929women.html

[12] Source, April 3, 2003: http://www.post-gazette.com/pg/03093/171152.stm

[13] Source, March 16, 2001: http://www.pcworld.com/news/article/0,aid,44675,00.asp

[14] Posted on June 24, 2005: http://www.acm.org/technews/articles/2005-7/0624f.html#item10

[15] Source: http://www.catalyst.org/

[16] Source, June 7, 2001: http://iwsun4.infoworld.com/articles/hn/xml/01/06/07/010607hnsurvey.xml

[17] Source, October 18, 2004: http://www.informationweek.com/story/showArticle.jhtml?articleID=49901107#_

[18] Source, April 29, 2002: http://www.informationweek.com/story/IWK20020426S0003

[19] Posted on January 8, 2001: http://www.acm.org/technews/articles/2001-3/0103w.html#item16

[20] Source, December 1, 2001: http://www.wired.com/news/women/0,1540,48733,00.html

[21] Source, January 234, 2003: http://nl2.vnunet.com/News/1138250

[22] Posted on September 18, 2000: http://www.acm.org/technews/articles/2000-2/0918m.html#item12

[23] Source, August 6, 2001: http://www.computerworld.com/cwi/stories/0,1199,NAV47-68-84-91_STO62757,00.html

[24] Resources, August 2, 2004: http://www.computerworld.com/careertopics/careers/story/0,10801,94897,00.html

A

Addressing the Gender Gap in IT via Women's Preferences in Video Games

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INTRODUCTION

We feel that it is essential to ask: Why study video games as a form of information technology? Are video games not a mindless and childish form of entertainment without any serious consequences requiring scholarly examination? We believe the answer to that question is a resounding "no". We propose that video games are one of the first samples of IT with which children come into contact and can have a profound effect on their acceptance of technology overall. It can be argued that the sooner children come into contact with and accept technology, the more likely they will be to sustain such activity into adulthood.

Interesting cultural aspects related to video games are arising as this form of IT generates interest in research communities, especially when examining the social dynamics of video game players (e.g., real time strategy (RTS) gosus, arcade junkies) and video gaming communities (e.g., role-playing game (RPG) clans, first-person shooter (FPS) sects). Similarly, the recent influx of games with mature content has increased the number of older video game players (Snider, 2002). Moreover, there are observable emotional and psychological effects that video game players experience. For example, some reports suggest that video games with violent themes can desensitize individuals (Violent Video Games, 2000).

Video games have become so popular and pervasive that they are transforming the modern world, and these effects are measurable at the individual, organizational, societal, and even global levels. The sheer economic impact alone of video games cannot be ignored; a recent article reports that the video gaming industry generated $9.9 billion in revenue for 2004 (Richtel, 2005). Finally, video games can be considered a "gateway to computer literacy" for children (DeBare, 1996). This also implies that video games have more of a role in a child's lifestyle than simply mindless entertainment.

Studying video games as they relate to gender and IT is thus a worthwhile endeavor with non-trivial ramifications. Specifically, studying how playing video games relates to gender differences in the IT work profession may provide interesting results because such an inquiry would identify a possible contributor to the gender gap noticed in the IT workforce today. Males have traditionally possessed a strong desire to interact with technology, which we posit is partly driven by increased exposure to video games. Males therefore appropriate artifacts of technology (e.g., computers, wireless, handheld devices, etc.) more readily than their female counterparts. Contrarily, females are being alienated from technology, which we believe is a causal result from their lack of positive video game experiences.

How video games affect the gender gap in IT could be explained in the following manner. The IT profession is considered a male-dominated and male-oriented field. If we include game developers as part of the IT profession, we find little exception to this dominance. Video games are thus designed from the minds of male game developers; Saltzmann (2001) reports that 99% of all game developers are men.

Video games conventionally have had a stronger appeal to males than females. Less than 30% of all video game players are female and the number of "serious" female game players is considerably lower (DeBare, 1996). For example, only 5% of *GamePro* magazine readers are female and only 8% of the buyers who returned product registration cards to Electronic Arts, a leading game design company, are female (DeBare, 1996). As a result, the majority of video games contain an emphasis on overtly male-oriented themes such as gratuitous sex and violence, extreme action, science-fiction themes, mythical fantasies, and sports. Due to this overly male-oriented content of video games, young males are naturally drawn to them. Therefore, we posit that young males have a "fun" or positive interaction with technology, while young females do not. Young males thus have an initial attraction to technology that is driven by video games, and consequently may have a strong desire to seek professions where technology is central to the work (e.g., programming, animation). Conversely, young females who lack this "fun" interaction with technology may miss the attraction, thus resulting in a lack of interest in pursuing a career where technology is essential.

Thus, we propose a research agenda that examines female interest in video games as a method to address the gender gap in the IT profession. We speculate that investigations into the gaming habits and gaming preferences of females can not only provide an understanding of women's interests in video games, but also lead to characteristics that can be emphasized to increase female interest in technology.

BACKGROUND

Much of the literature concerning gender-related video game preferences focuses on negative appraisals of the depiction of women by the gaming industry and its predominantly male design and programming staffs. Research has found that pre- and post-adolescent females are displeased with many of the features in video games. This is most clearly evident in research where avatars, the electronic representation of a player in a video game, are critically examined. Avatars can be graphically represented on a video screen, or consist of sets of textual descriptions including vital statistics such as height, weight, and age. Lois Salisbury, president of Children Now, is quoted in a CNN.com feature (2000, para. 13) as saying, "there is an interactivity, there is an absorption, and the children who are playing are actually assuming different characters [avatars]. That does a lot for identity formation."

Many female interviewees reported that they find much of the content in video games sexist and degrading due a continual display of female avatars as enhanced sexual objects (Cassel & Jenkins, 1998; Saltzmann, 2001; Swanson, 1995; Wilcox, 1996). In a study commissioned by Children Now, the child advocacy group found that in the top ten best selling games for three popular game console systems, female characters were displayed in an "exaggerated and stereotypical manner" (CNN, 2000). Children Now also found that 38% of female avatars were depicted with considerable body exposure (CNN, 2000). Girls tend to not only disdain the prototypical large breasts coupled with an impossibly small waist of female avatars, but also the use of high-pitched giggles, sighs, and whimpers in voice-acting (Cassel & Jenkins, 1998; CNN, 2000).

Body image, while a prevalent topic in today's gaming market, is not the only feature alienating female gamers. One of the more established stereotypes of female characters viewed negatively by female respondents is the "damsel-in-distress" character, such as the tried-and-true "trapped princess formula" used in games such as *Super Mario Brothers* or *Prince of Persia* (Kiefaber, 1998; Saltzmann, 2001). Likewise, in instances where male characters are in need of rescuing, women rarely save them (QuickFacts, n.d.).

Female interviewees cite violence as another detractor in video games. Violent games, such as *Mortal Kombat* or *Quake*, are shunned by females for several reasons, including lack of intellectual stimulation (Wilcox, 1996), repetitive structure of violent behavior (Wilcox, 1996), and aversions to blood and gore (DeBare, 1996). The results of a survey administered to 137 high-school teens by the National Institute on Media and the Family and the University of Oklahoma show that the average teen enjoys a "moderate amount of violence" in video games, "roughly 5 on a scale of 1 to 10" (QuickFacts, n.d.). Unfortunately, this statistic is skewed since it incorporates young males' perspectives as well as their female classmates. When limited to male responses only, the average teen "likes a fair amount of violence", which was determined from an average response of 7 on the same 1 to 10 scale (QuickFacts, n.d.).

Inspired by an article written by a female staff member from GameGirlz.com, Phillipe O'Connor (2000) put forth a biological argument to explain women's deterrence of video games. His work states that feminine instinct directs women away from deriving pleasure from violent games whereas, based on evolution, males may experience satisfaction in such aggression. The argument is further supported by showing the significance of childhood games such as "House" and "Hide and Seek" in the following:

If we accept the fact that playing is a type of animal behavior that evolved to help us survive ... a primarily instinctive behavior, as opposed to learned, then we can move onto the specific topic of male and female play, which dare I suggest, is also largely based on instinct. (The Biological Roots of Gaming section, para. 6)

This article insists that women receive pleasure from personal interaction in a social group, and thus video games containing content similar to soap operas would be successful.

Identification of these factors by researchers has led to the creation of several female-owned and largely female-staffed companies such as HerInteractive, Girl Games, Girltech, and Purple Moon. Even so, a dichotomy exists regarding the success of these companies and video games targeted specifically towards a female audience. Cassel and Jenkins (1998) cite that *Barbie Fashion Designer* sold over 500,000 copies in its first two months, a figure which exceeded sales of so-called male-centered games such as *Doom* and *Quake*, as a positive. In her thesis, *Computers and the Internet: Listening to Girls' Voices*, Dee Dee Wilcox (1996) presents a contrasting viewpoint based on her respondents, stating that games such as *Barbie: Super Model* or *Girls Club* were not appealing since they focused on outward appearance and sexual appeal. Similarly, many girls regard these games as too "girly-girl" (Girls and Video Games, 1999; Hamilton & Hokanson, 1999), or representative of stereotypical, even sexist, viewpoints of male software designers (Cassel & Jenkins, 1998; Wilcox, 1996).

MAIN THRUST OF THE ARTICLE

Two insufficiencies surfaced during our examination of the literature. First, there is an incomplete treatment of the full age range of young females. Much of the research detailed in the previous section focused on young girls, mostly pre-adolescents between the ages of 6 and 12. In fact, the literature reviewed is rather exhaustive in covering this age group. While recent studies have extended attention to high school-aged teens, they lack significant examination of collegiate-aged and older women. Statistics show, consequently, that the gaming age of women has extended well beyond 21 in recent years, especially as technology becomes a more central part of lives (Snider, 2002). Thus, we consider it important that research conducted on this topic include collegiate-aged and older women audiences, presumably females between the ages of 18 and 27 since this would follow the demographic makeup of workers in the IT sector.

Similarly, the literature is "inadequate" in that it does not "sufficiently incorporate different perspectives and views of the phenomena under investigation" (Golden-Biddle & Locke, 1997). There is an extreme emphasis in many sources on the negative aspects of video games that have led females away from video game playing. Additionally, there is disparity over preferences, particularly those voiced by proclaimed feminists (Cassel & Jenkins, 1998) against those of female-owned and operated gaming companies and even the females interviewed and observed in some articles (Bergman, 1998; Wilcox, 1996). Several articles (Buchman & Funk, 1996; DeBare, 1996; Girls and Video Games, 1999; Kiefaber, 1998; Saltzmann, 2001) attempted to explain what females preferred, but most often strayed from the features that could build a "pro-female" game, and focused upon what was perceived as poor with current designs. This article asserts that research should seek the characteristics of video games that women prefer and build upon those preferences in a positive manner.

We focus the remainder of discussion using the following research question: *What features/characteristics of video games are most likely to appeal to a female audience?* This question is intended to drive a research program to discover and be able to describe the specific features and characteristics that attract females to video games. We propose that such a study should be performed qualitatively, rather than quantitatively, for three reasons. First, the research question seeks to understand the meaning behind the quantitative data consistently cited in the literature. As detailed in the previous section, females are an underrepresented group in the video gaming industry, both as players and designers. The reasons behind this lack of representation are complex and require a deeper level of analysis than quantitative methods afford. Our suggested research program seeks to understand the features of video games that women find most appealing and engaging. Thus, the data that this research would obtain will not be numerical in nature, but rather richly descriptive and qualitative in nature.

A second rationale is the amount of uncertainty concerning female video game preferences. Such game features are not well understood, as we have shown in our discussion of the literature. The disparity and conflict over what game features women find most appealing creates ambiguity. Additionally, what women find appealing about video games is not clearly documented, though there is considerably more literature concerning this phenomenon than we initially anticipated.

Finally, we suggest approaching this research with an emic, or insider, perspective. Through this research, researchers will delve deeper into the mindsets of female video game players and discover what women desire in a video game. The research seeks the reasons and influences for why women do or do not play video games. Additionally, the research focuses on the discovery of what features alienate women from playing video games and identification of the characteristics that increase their desire to play. Previous experience and the knowledge level of video games by researchers will affect perspective and determine whether qualitative methods are appropriate. However, we feel that researchers should feel comfortable immersing themselves in the research due and possess a certain amount of familiarity and interest with the research topic in order to be successful.

FUTURE TRENDS

We recommend two research methods for studying this phenomenon: a case study involving collegiate-aged women and an ethnographic study (if possible) of female video game players. Additionally, research instruments such as surveys and semi-structured interviews, as well as participant observation opportunities, would provide researchers with rich, descriptive data. Table 1 details possible survey and interview questions appropriate to this research initiative. These instruments would also allow researchers to immerse themselves in the female video gaming culture. For instance, the semi-structured nature of the interview allows researchers to ask additional questions of participants, particularly when an interest in a particular question or certain topic is noticed. As an example, suppose one participant mentioned that she liked playing the game *Tomb Raider*, which features the buxom lead character Lara Croft, in response to an interview question (see Table 1). The researcher could then inquire about the participant's feelings regarding the design of the avatar. Having such a flexible format allows researchers to more readily gather finer grained information from a participant.

The information we regard essential for discovering the video game preferences of women is gaming history, current gaming frequency, favorite video games, and the features that are most appealing about those games. Gaming history and current gaming frequency present preliminary background about a person's gaming habits. We define gaming

Table 1. Possible survey and semi-structured interview questions

Survey Questions
• *Have you ever played a video game?* • *Do you currently play video games? If so, how often?* • *What are your favorite game titles?* • *What games are you currently playing?*
Interview Questions
• *Have you ever played a video game?* • *If so, what are your all-time favorite video games?* • *How often did you play in the past?* • *Do you currently play video games? If so, what games?* • *How often to do you play?*

history as the types of video games the person played in the past and how often they played video games. Subsequently, current gaming frequency is the amount of time a person currently plays video games. Thus, these two factors together provide a clear picture of overall gaming habits for a person. For example, the information that a female who has played one video game in the past, played it sparingly (gaming history), and is not currently playing any video games (current gaming frequency), yields that this person has had little exposure to video games and/or may dislike video games in general. Conversely, a female that has played a large number of video games in the past, played them at a high frequency, and continues to play video games regularly shows that this individual has an avid interest in video games.

Knowing a person's favorite video game allows the researcher to examine the characteristics that are common among them. Knowing interviewees' favorite games allows us to uncover the qualities and features of video games that appeal to them. Therefore, even though the features of video games that women prefer can be sought by asking straightforward questions in a survey or interview question, popular features, which may be more subtle, may be drawn out by examining the person's favorite games.

CONCLUSION

Past studies have attempted to generalize the video game preferences of women. We feel, however, that female interests in video games are too divergent to be generalized. In fact, we suggest the opposite of what was discovered in the literature, namely, that the video gaming industry needs drastic transformations if it is to appeal to women. We recommend that qualitative research methods be employed to uncover the video gaming preferences of collegiate-aged women. By performing case studies, ethnographic observations, and conducting surveys and semi-structured interviews, we believe that the gaming habits and gaming preferences of females can be revealed. Video game developers should treat women as individuals, rather than a group when it comes to addressing their interests. Perhaps only then can women feel included in the video game community.

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KEY TERMS

Avatars: Graphical representation of a user in video games, usually associated with the main character or player.

Console: A dedicated electronic device designed to play video games.

First-Person Shooter (FPS): A video game that is played from the first person perspective (e.g., looking out of the eyes of the main character). To achieve the "shooter" aspect, the character usually wields some type of weapon.

Gosu: Refers to a person with great skill in video games, especially RTS games.

Real-Time Strategy (RTS): A type of strategy game that progresses in "real time"; that is, it is continuous rather than turn-by-turn. The word *strategy* originally referred to planning at the level of armies and squadrons rather than giving orders to individual units or persons.

Role-Playing Game (RPG): A type of game where players assume the roles of fictional characters and involve interactive and collaborative storytelling; typically take place in fantasy/science-fiction settings.

Video Games: A game composed of a computer-controlled virtual universe that players may interact with in order to achieve a goal (or set of goals). *Video game* is frequently used as an umbrella term for interactive game software.

A

Age, Gender, and Cognitive Style Differences in IS Professionals

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INTRODUCTION

There is a long tradition of research on IS professionals that has examined potential gender differences between men and women, beginning with early studies by Igbaria and his colleagues (Guimaraes & Igbaria 1992; Igbaria & Chidambaram 1997; Igbaria & Siegel 1992). While these and many subsequent studies posited differences between men and women IS professionals, very few differences have been found—particularly for variables that are commonly studied: job satisfaction, turnover intentions, organizational commitment, and stress. I first summarize the results from many survey studies published in leading IS scholarly journals, as a way to frame my research on the adaptation of IS professionals to innovations in work practices. Then I summarize my program of research examining demographic variables, including age, gender and cognitive style differences as explanatory variables for a range of outcomes among IS professionals.

LITERATURE REVIEW

Research on Gender, Job Satisfaction, and Job Turnover

Numerous studies have consistently sought—and failed to find—gender-related differences in job satisfaction, turnover intentions, organizational commitment, and other job-related attitudes. One difference that has been frequently noted in studies of IS professionals is that women, in general, have fewer years of experience in the IS profession—not surprising, considering the delayed entry of a sizeable number of women to the IS field (Baroudi & Igbaria, 1994/1995). Various comparative studies have reported that the average job tenure of women IS professionals is less than for men, and that women respondents are younger than their male counterparts (Sumner & Niederman, 2003/2004). However, with the exception of a few studies of job stress among IS professionals, most studies that have posited gender differences in job satisfaction, turnover intentions, and organizational commitment have come up "empty handed." One recent study, in fact, examined 34 potential differences related to the career history, salaries, job search behaviors, and job satisfaction of IS graduates in the U.S., finding surprisingly few differences in the career experiences of men and women. The only differences noted were that women were more satisfied with their pay than men (despite women's lower salaries), and that, when they did change jobs, women took longer, on average, to actually leave (141 days for women vs. 75 days for men). All other variables were similar for the men and women, prompting the authors to remark that employees seem to "experience an even playing field in the IS profession, regardless of gender" (Sumner & Niederman, 2003/2004, p. 36).

While it is widely believed that women IS employees have higher turnover rates than men, no empirical study has documented such an effect. The one study that found a significant difference in turnover intentions between men and women reported that "a woman is more likely to estimate *longer* continuing employment at her firm than a man" (Baroudi & Igbaria 1994/1995, p. 198).

Studies of Job Stress

While there has been a growing literature on job stress among IS employees, few consistent gender-based differences have been found. Of more than a dozen studies that have examined job-related stress among IS professionals, however, we note that half of the studies neglected to conduct *any* gender-related analyses (Baroudi, 1985; Igbaria, Parasuraman, & Badawy, 1994; Sonnentag, Brodbeck, Heinbokel, & Stolte, 1994)—in many cases, even neglecting to mention what proportion of the sample was women (King & Sethi, 1997). Of the few studies that reported what proportion of the sample was women and provided at least a rudimentary analysis of gender differences, most researchers found no gender differences in job stress (Guimaraes & Igbaria, 1992; Igbaria & Chidambaram, 1997; Moore, 2000). One study of IS workers in Singapore, however, identified differences—with women reporting higher levels of work-family conflict, as well as greater stress arising from interactions with supervisors and coworkers (Lim & Teo, 1999). Another recent study of U.S. workers also found that women reported higher levels of job stress (Sethi, King, & Quick, 2004).

Studies of Job Performance

While many studies of IS professionals have examined affective constructs (such as job satisfaction and stress), few studies have examined job performance—and the few studies of job performance have generally neglected gender (Rasch & Tosi, 1992; Wade & Parent, 2001/2002). While most of these studies have reported the proportion of women in their sample (and nothing more), some studies have neglected to report even this (Clark, Walz, & Wynekoop, 2003). One study that conducted a gender comparison of supervisors' ratings of IS workers' performance found no gender differences (Igbaria & Baroudi, 1995). A second study found that women IS workers were more *conscientious* than men and that conscientiousness was, in turn, strongly related to two dimensions of IS professionals' performance (Witt & Burke, 2002). The latter study examined the relationship between performance and the "Big 5" personality factors often studied in psychology research.[1]

MAIN THRUST OF THE ARTICLE

Given this body of prior literature and my own interest in studying how knowledge workers adapt to using new technologies in their jobs, I have been engaged in ongoing research to understand what factors shape individuals' abilities to adapt to using new technologies. My research examines whether demographic variables (e.g., age, gender, job tenure) or cognitive style differences explain IS professionals' ability to adapt to technological innovations and related changes in work practices. Over the past decade, there have been numerous technological innovations that have been introduced in the work of IS professionals and many early writers posited that demographic variables—namely age—would explain the difference between those employees who successfully adapt to these changes vs. employees who do not adapt well. While researchers in this area rarely mention gender as a factor that affects IS professionals' ability to assimilate change, scores of studies appearing in IS trade magazines posited age as a factor—often labeling older IS workers as "old dogs" incapable of learning new tricks (Ambler, 1994; Betts, 1992).

I conducted a longitudinal, mixed-methods study during the mid-1990s to understand how organizations were implementing one popular innovation that changed the practices of IS workers at that time (client/server development). In my study, I examined the implementation processes in four large organizations in the northeastern U.S., combining interviews of IS managers, IS employees, HR managers and training specialists with surveys of IS employees and managers. Interviews in the four firms showed that companies used a broad range of approaches to implementing client/server and "reskilling" their IS employees. These approaches ranged from firms that conducted a highly-structured, centralized initiative to reskill employees—as occurred in one financial services organization (Gallivan, 2001a) to another firm that essentially paid "lip service" to the notion of reskilling their employees to perform client/server development. The latter organization, while promoting the need for employees to "take charge of their careers," was actually in the process of drastically reducing the size of their IS workforce through voluntary lay-offs and other involuntarily measures (Gallivan, 2001b).

The two other firms followed different approaches—with one firm simply hiring new employees with the requisite client/server skills rather than retraining current employees, and the other firm expecting its employees to maintain their technical currency mostly in their "spare time." Not surprisingly, many of these employees in the latter firm (an engineering firm) emphasized the long hours they had to spend to keep up (Gallivan, 2003a). One of these employees referred to his approach to learning client/server as "baptism by fire," while another explained her approach as:

The brute force method: dive into the books and don't come up for air until the final page. Immediately apply [what I've learned] until everything clicks!

In another case, an IS manager from the engineering firm explained which employees succeeded:

We hire good people, throw them in a slot, and get the work done. We see which ones [rise] up. One example was a woman who had her nose in front of the computer terminal all the time, working on it. We had to throw her out [of the building] at night.

In both my interviews and subsequent survey research, I sought to identify whether individual demographic factors (e.g., age, gender, and job tenure) could explain employees' ability to assimilate client/server development–and their attitudes toward it—or whether personality and cognitive style attributes were the underlying factors that shaped employees' outcomes. In the interviews I conducted, neither age nor gender was mentioned by my informants as an explanation for employees' ability to adapt to using client/server. Rather, they mentioned a host of factors—ranging from having experienced other skill transitions in the past to cognitive style attributes. I examined these three cognitive style attributes in my survey—*tolerance of ambiguity* (Gallivan, 2004), innovativeness, and personal *resilience* (Gallivan, 2003b).

My survey examined five sets of outcome variables as indicators of employees' ability to adapt to client/server development and associated changes in work practices. These included (1) attitudes to the client/server innovation itself; (2) employees' job satisfaction; (3) job stress; (4) turnover intentions; and (5) the supervisor's evaluation of employee's job performance. I examined job performance along several dimensions that had been reported in prior studies (Goldstein, 1988)[2]. My employee and manager surveys (based on two of the original firms) showed that gender was related to only one of these outcome variables at conventional levels of statistical significance: job stress. Women employees reported higher levels of job stress, as a whole, and especially in the engineering firm that expected them to "reskill" themselves largely on their own time (Gallivan, 2003a). In fact, women in this firm reported much higher levels of stress than all other employees; moreover, both the men and women in this firm reported insufficient supervision—revealing the belief that they were expected to do too much on their own (Gallivan, 1997).

Other than this difference in job stress, there were no other statistically significant gender differences for any of the other outcome variables—which is consistent with prior studies of IS professionals that examined gender. There was a slight trend in my survey data for women IS employees to report higher levels of job turnover intentions (which was weakly significant, at $p < 0.10$), but this result appeared only after statistically controlling for employees' job satisfaction. I interpret this finding to mean that after controlling for employee job satisfaction (which is the *primary* determinant of job turnover intentions); women IS professionals were slightly *more* likely to consider leaving than men. There was no difference in the level of job satisfaction for men or women, however. There was some anecdotal evidence (based on responses to general, open-ended questions at the very end of the survey) that the women's slightly higher turnover intentions were due to their concerns about childcare. Several optional, open-ended comments added by some women suggest such an explanation (although it is impossible to know for certain whether this accounted for the women's slightly higher turnover intentions):

With regard to [my plans for] leaving this company, I'd like to clarify that I sometimes think about leaving to become an independent consultant. I already have ... the skill set to work on my own. This is attractive to me primarily because I'd like to cut back on the number of hours I work to spend more time with my daughter; however, I haven't done this yet because of the benefits I receive here.

Regarding the question of leaving my employer, I would very much like to work closer to home. The convenience of a workplace is very desirable to me, and working [here] is not very convenient.

In summary, my survey data showed that gender had a statistically significant relationship with job stress only (which was exacerbated in the engineering company), but no differences in the other four outcome variables. In contrast to the general lack of gender differences, I found that employees' age was inversely related to their supervisors' evaluation of their technical skills, but age was not related to the other dimensions of job performance (business knowledge, job attitudes, and communication skills). Based on my results, there appears to be some truth to the conventional wisdom that younger employees are more technically adept than their older counterparts. However, it is also worthwhile to consider that perhaps IS supervisors "buy in" to the notion that older workers are less skilled technically, since the job performance data were based on subjective evaluations from supervisors, rather than objective measures of employees' skills or work outputs. Moreover, the fact that there were no other age-related differences on other dimensions of performance raise questions about the conventional wisdom that older IS workers are "dinosaurs" (Betts, 1992) or "old dogs" (Ambler, 1994) who cannot adapt to new technologies. I even found that supervisors' ratings of employees' business knowledge were *positively* related to how long employees' had worked in the IS field—thus suggesting that more experience on the job is an asset—not a liability—for IS workers.

In examining the three cognitive style variables (tolerance of ambiguity, innovativeness, and personal resilience), I found that all three attributes were positively linked to employees' job satisfaction but all were unrelated to gender—as I had hypothesized. To my surprise, however, none of these cognitive style attributes were positively associated with job performance. In fact, personal resilience was *inversely* related to supervisors' evaluations of employees' business knowledge (Gallivan, 1997, 2004). This was a startling finding, and one that I have struggled to interpret. Yet the interpretation is revealing: employees' stock of business knowledge increases with their length of time in the company and in the IS field; however, more resilient employees have a greater "appetite for change," and thus, the highly-resilient employees are less likely to remain in a given job than their less-resilient peers. Thus, IS employees who are highly resilient are more satisfied in a given job but, in part, because they are so attractive to other employers, they tend to be lured away to new job opportunities (Gallivan 1997). This reflects a "double-edged sword" to having employees who are highly resilient: they may not remain in a given firm as long and hence, may not amass as much knowledge of the firm's business.

CONCLUSION

To summarize, I found four results for the demographic variables that I studied: first, gender was related to job stress, with women reporting higher levels of stress; second, age was inversely related to supervisors' ratings of employees' technical skills; third, all three cognitive style variables were positively related to employees' job satisfaction following adoption of client/server; and fourth, personal resilience was inversely related to supervisors' ratings of employees' business knowledge. While my findings are consistent with prior research in terms of the general *lack* of differences between men and women IS professionals on most outcomes (e.g., job satisfaction, job performance, turnover intentions, etc.), the higher levels of job stress that I found for women IS professionals were consistent with two recent studies (Lim & Teo, 1999; Sethi, King, & Quick, 2004).

FUTURE TRENDS

It is not known whether *all* IS jobs are more stressful for women IS professionals, or whether this effect is only present when women perceive themselves to be token workers within a "male-dominated majority culture" (Kase & Trauth, 2003, p. 1559). Some evidence for the greater incidence of stress among professional women who work in male-dominated fields has been documented by management scholars in a range of industries (Gardiner & Tiggeman, 1999). Although my results cannot shed light on this question, an interesting question for follow-up research is whether higher levels of job stress among women IS professionals disappear or become less problematic in firms that have a large proportion of women IS professionals (or women employees, in general). While the issue of turnover as a function of the proportion of women employees has been examined by management researchers in other industries (Elvira & Cohen, 2001)—with mixed results—I consider this to be a worthy topic for follow-up studies by IS researchers.

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KEY TERMS

Client/Server Development: An approach to developing software applications, introduced in the 1990s, that uses PCs with graphical user interfaces and specialized application development tools to replace conventional programming with third-generation languages (3GLs), such as Cobol or C.

Resilience: The psychological attribute of being able to endure stressful life events.

Reskilling: A term, popularized in the early 1990s, to describe IS employees learning new skills.

Tolerance of Ambiguity: The ability to feel comfortable in unfamiliar, new, or ambiguous situations.

Technological Innovation: A new tool or software development methodology.

ENDNOTES

1. The "Big 5" personality variables are conscientiousness, agreeableness, extroversion, emotional stability, and openness to experience. Witt and Burke (2002) found that women were more conscientious which was, in turn, related to supervisors' ratings of employees' relationship management skills and quality of technical documentation.
2. I examined four performance facets: technical skills, business knowledge, communication skills, and job attitudes.

Analyzing Gender Segregation in Computing

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INTRODUCTION

Gender appears to be a fundamental category for ordering and classifying social relations in the world (Evans, 1994). The first thing we are told about a newborn is whether it is a boy or a girl. Gender as defined by Acker, (1992, p. 250) is a "patterned, socially produced distinction between female and male, feminine and masculine" and is a key concept for understanding the degree of male and female participation in any field, including information systems. This review aims at developing an understanding of some of the reasons that underlie (a) the gender segregation that exists within the broad, interrelated fields of computing (information systems (IS), information technology (IT), and computer science (CS)) and (b) the declining levels of female participation in the computing industry across the continents. The three computing disciplines (IS, IT, CS) and the computing profession clearly appear gender segregated, with a male dominance at all levels. As Booth (1999) noted, while one of the first software ever written for a machine was produced by a woman—Ada Lovelace in 1840, it is a male, Charles Babbage—the inventor of the difference calculating machine—that is generally accepted as the founding father of computing. Booth concludes: "And that, in microcosm, has been how the IT industry developed over the next 160 years—a combination of rapid technical advances leading to skills crisis while half the nation's workforce has been routinely overlooked" (p. 47).

BACKGROUND: THE GENDER DIVIDE

Even if recent data and trends show a slightly improved scenario, the number of women in computing still remains a minority. Women participation rates in the IT sector have fluctuated somewhere between 19% and 22% during the 1990s (Robertson, Newell, Swan, Mathiassen, & Bjerknes, 2001), whereas since the early 1990s the overall female participation rate in the labor force has never fallen below 45% (Panteli, Stack, Atkinson, & Ramsay, 1999).

Women continue to be segregated both horizontally and vertically, both in academia and business. In terms of horizontal segregation, women are found working much more often in what are considered to be "softer" aspects of this profession, for example, in sales, marketing and support functions such as help desk and customer service. These areas require superior interpersonal skills and women tend to be gender-stereotyped as almost naturally having such skills (Wilson, 1999). Men continue to dominate in technical areas such as analysts/programmers (Panteli et al., 1999). In terms of vertical segregation, computing is still dominated by men and the imbalance is more striking on the higher levels of the corporate hierarchy (Candee, 1997). Candee provides a number of examples to illustrate this vertical segregation. For example, in the Society of Information Management (SIM), a U.S. organization of senior IT executives, only 195 of its 2700 members were women in 1997. This segregation is reflected in continued wage differential (Panteli et al., 1999) as the average compensation does not rise equally. According to a CRN (2004) salary survey, solution providers handed out bigger raises to male managers than to their female counterparts. In 2003, wages grew an average 7.7% to U.S. $101,000 for men, while compensation for female managers grew an average of 2% to U.S. $87,900. Nevertheless, the gender gap among IT managers was found to be smaller than in most U.S. industries. The government accounting office (GAO) reported that women in 2000 were being paid 80 cents for every dollar men were paid for similar positions, a gap that has remained relatively steady over the past two decades (CRN, 2004). In contrast, solution providers were paying their female managers 87 cents for every dollar paid to the male managers. The 2004 CRN report also noted that while large IT companies tend to pay better than their smaller counterparts, when it comes to raises, smaller companies tend to be more generous.

Male dominance in the business areas of computing is similarly reflected in academia both in teaching and student enrollment levels. In the teaching area, for example, in the 1998 European Conference on Information Systems (ECIS), only 35 of the 300 participants were women. Female students enrollment rates in computer science courses across the U.S. and Europe at all levels (undergraduate, Masters, and PhD) declined quite dramatically throughout 1980s and 1990s (Lander & Adam, 1997; Panteli et al., 1999). The number of women enrolling in computing courses fell from a high of 28% in 1978, to 13% in 1995, and down to 9% in 1998 (Booth, 1999). In other words, the computing discipline continues to mainly attract men to educational courses and, subsequently, to more senior technical positions in this industry.

This situation is distinctive of the computing field and appears to be the core of the problem. While female participation in computing is at a decline in many other academic fields, women representation in other disciplines has steadily increased and is becoming more reflective of overall population patterns. For example, in the UK, the number of women across all academic disciplines constitutes almost one-half of the undergraduate population (Robertson et al., 2001). Many traditionally male dominated academic disciplines—such as medicine and veterinary sciences—are witnessing significant increases in female participation rates (Grundy, 1996).

In view of the previously mentioned findings, and in an attempt to better understand the reasons of this "gender divide," it is worthwhile to examine the specifics of gender segregation in computing.

ANALYZING GENDER SEGREGATION IN COMPUTING: A REVIEW OF KEY ISSUES

The gender-based segregation in IT could be considered a reflection of the broader pattern of horizontal and vertical segregation that exists in society, rather than anything specific to computing. This presumption frees the professional community from any responsibility to take action to promote change. If we are to encourage women to enter the field of computer science, information technology, and management information systems, we should focus on promoting a debate within the field to stimulate the necessary changes. Understanding the drivers and key examples of gender segregation is a pre-requisite to initiating a dialogue.

Techno-Hazing (or Overt Gender Bias)

In some cases, the segregation of men and women within the computing profession is a result of blatant/overt gender bias. For example, DiDio (1997) interviewed a number of women in Silicon Valley and found numerous examples of women still grappling with problems of being assigned manual tasks, whereas their male colleagues with similar backgrounds were given a "choice" of assignments. DiDio coined the term "techno-hazing" to describe this phenomenon of gender bias. Techno-hazing refers to the bias that results from the assumption that women cannot be technically competent; and even when qualified, they are given lower complexity jobs or are supervised more closely. When blatant discrimination is visible, there is room for fairly direct actions, such as legislations. Many companies and Universities already have Equal Opportunities Policies that attempt to go further than simply complying with the legislation. For example, many Universities require employees across the organization to take sexual harassment and sensitivity classes (and they require that all employees be certified in such courses).

Latent (or Covert) Bias

However, while initiatives such as those described above can help to combat direct discrimination, they do little to eradicate indirect, subtle, and insidious discrimination. This indirect gender bias is not really seen or acknowledged. Therefore, it is more difficult to address. As Meyerson and Fletcher (2000) observe, gender inequity across the industry has not vanished, but has simply gone underground, perpetuated "in a plethora of work practices and cultural norms that only appear unbiased" (p. 127). Covert discrimination continues to take place because of gender-biased beliefs about jobs, tasks, roles, and people that are communicated and indirectly reinforced continuously within organizations (Wilson, 1997).

There are three processes perpetuating these covert biases: (a) the marketing and pedagogic design of IT and IS; (b) the exclusion of women from important and influential networks; and finally, (c) the difficulty in gaining legitimacy as experts in IT and IS fields. Each of these processes is briefly described as follows.

a. **TheMarketing and Pedagogic Design of IT and IS:** Part of the problems in recruiting female graduates relate to the course content and how it is presented and taught. As Booth (1999) comments: "Few women yet see IT as a desirable profession, which is a reflection of its techie image." While the computer itself displays no gender bias, the computer culture and the socially constructed discourse that surrounds computing is not equally neutral. Wilson (1997) suggests that there is a legacy in computer cultures of masculine images of competition, sports and violence, enhanced with a discourse that resorts to using phrases such as "killing a job," "aborting a program," "work-benches," "tool-kits," "drives," "engines," and so forth that are commonplace jargon with masculine connotations. How can we begin to address the dominant socially constructed masculine world of computing if technical courses display computing as a "man's job"?

b. **The Exclusion of Women from Important and Influential Networks:** While female student numbers are small and appear to be falling, there is an even greater problem in terms of women actually working in the profession in industry or academia. According to a study entitled "Opportunities and the Gender Pay Equity in New Economy Occupations" issued by the White House Council of Economic Advisers in May, 2000 (Bentsen, 2000), it was noted that women in the U.S. make up only 29% of workers in IT occupations, compared with 47% in the general workforce. The White House study also found that women in IT earn an average 60% more than women in other occupations. Even though the opportunities are there, female IT share in the workforce fell from a peak of 40% in 1986 to a current low rate of 29%. Robertson et al (2001) noted that across University computing departments in the UK, women constituted only 13.4% of lower level teaching and research posts, falling to 6% at senior levels. About 18% of computing departments did not have any women among the faculty (Grundy, 1996). Since these departments are responsible for the pedagogical design and marketing of computing courses, the lack of women, particularly in influential positions, must be considered a critical issue. If there are too few female academics within the field, their presence and influence within important powerful networks in the computing arena will also be minimal (an example was the 2000 ECIS conference attendees' distribution).

   Networking has always been recognized as a crucial element in career progression. Because of such poor representation, it becomes difficult for women to affect changes to the current status quo. As Hemingway (1995) and Meyerson and Fletcher (2000) noted, women actually encounter a "Glass Door" on entry to the international computing community rather than encountering the better known "Glass Ceiling" as their careers progress.

c. **Legitimizing Claims to Knowledge:** Finally, legitimizing claims to knowledge- legitimacy as a female expert in the computing field is yet another issue centering on gender related segregation. A number of studies have shown that successful completion of computing courses in college is only a beginning.

Women in the computing industry often encounter further problems associated with patterns of communication between genders that can make some aspects of IS/IT projects or research problematic. The academic literature presents examples that when attempting to negotiate access to data in organizations, a female researcher is confronted with communication barriers (Robertson et al., 2001). Robertson states that these barriers did not apply in the same way to their male research fellows, perceived as more reliable content exerts even when they were less qualified than their female counterparts. Robertson also found that women in IT face fewer problems in Sweden than in the UK. Institutional differences in training and education, the perception of IT management in these nations as well as national differences in managerial attitudes towards university-based research is responsible for such disparity.

Women's Attitude Towards IT/IS

In a two-year study released in April 2000 entitled "Tech-Savvy: Educating Girls in the New Computer Age", the American Association of University Women (AAUW) suggests that the vast majority of girls and women hate information technology. The AAUW study indicated that girls are not necessarily computer phobic but they prefer occupations that are more socially inclined. Most of the women are unaware of the social implications of computing and more creative career paths within IT are not pursued. The academic literature presents numerous studies related to various aspects of women involvement in management information systems. Dattero, Galup, and Quan (2004) noted that most women in the MIS/IS/IT field work in mainframe systems and COBOL programming, whereas newer technology areas like Oracle, JAVA, and C++ are dominated by men. Women in MIS focus more on reporting functions rather than engineering new ones. In studies conducted on 80 MBA students (52 men and 28 women), Hartzel (2003) found that males and females differ in their self-efficacy levels of software use. In the post trials, there was an overall increase in the perception of self-efficacy both among men and women. However, men tend to have significantly higher self-efficacy (a mean pretest score of 4.89) as opposed to women (mean score of 4.64). Supporting self-efficacy is important because it affects one's willingness to invest efforts into purchasing, learning, and using specific software applications.

FUTURE RESEARCH AND RECOMMENDATIONS

The age-old arguments of physical weakness which led to lower payments for women in manual (labor) jobs do not have any basis for such inequities when it comes to the field of IS, as computer related tasks are not managed through physical force. Has this led to decreased discrimination in employment rates, compensation, promotion, and training for women compared to her male counterpart? Based on the review conducted in this article, it does not seem to be the case. The old gender-divide survives across nations. The UK, Scandinavian countries (Sweden) and the U.S. are just some of the economies analyzed. The review still points to the fact that women are under-represented in the field of IS, whether in the academic or business areas. In order to understand the overall gender issues in computing, considerable attention needs to be given to the interrelationships that exist between communication processes, social networking, and legitimizing claims to knowledge overlaid by gendered-powered-relations.

This discussion opens a number of suggestions for future research and provides some recommendations.

FUTURE RESEARCH NEEDS

Communication is essential for understanding gendered relations which are formed and affected through socialization and mutual interactions (Newell, 1999). Gendered relations of power within organizations and academic disciplines are reproduced through communication networks and interactions. Exploring the connections between communication practices and the underlying power structure might help understanding the patterns of overt and covert discrimination.

Studying the reasons behind the lower female representation in MIS is particularly important in view of a collapsing birth rate in the developed world (also termed "collective national suicide" by the renowned thinker of management studies, Peter Drucker) (Drucker, 2001). In the next couple of decades, there will be a decline of skilled workers in every industry, including the field of IT/IS. This being the case, it becomes important to be prepared to deal with the severe labor problem that may arise. This implies empowering the entire labor force, including the women currently excluded from the field, to take a more active role in knowledge capturing, maintenance and creation.

Finally, technology has enabled human beings to work through telecommuting. Physical distances have been rendered meaningless. Women can finally attempt to reconcile an ideal career path, which provides flexible hours and working from home, with a number of household and childcare responsibilities that still affect their lives even when they are part of a shared commitment and distribution of family responsibilities. Sue Rosser (Rosser, 2003) conducted a longitudinal survey contacting the POWRE Awardees (Professional Opportunities for Women in Research and Education), an NSF program that funded tenure-track women engineers and scientists at large universities. She contacted the awardees first in 1997 asking what significant issues they faced as women scientists and engineers. Nearly 63% of respondents singled out "balancing work with family responsibilities" as their biggest challenge. She repeated the survey with POWRE awardees in 1998, 1999, and 2000, and found even greater consensus—73 to 78% of respondents said that balancing career and family was their major problem.

The questions on how to reconcile the conflicting needs of being part of a physical network with the needs of obtaining a work-life balance (through disconnecting from the same face-to-face network) still remain open.

RECOMMENDATIONS

Computer science should be presented as a field that is interdisciplinary and focuses also on a social purpose. Stimulating interest and awareness in the IS/IT/CS curriculum across a far more diverse range of individuals is likely to be the most successful strategy for encouraging gender mix. A radical redesign of computing courses is highly recommended. For example, offering combination of group dynamics, and even home-science courses with IT courses would be a good mix to attract women to a computer science curriculum. The London School of Economics (LSE) has been able to increase the number of women enrolling in computing courses by introducing home science across programs. By changing the computer science courses and the admission procedures, Universities could replicate Carnegie Mellon's success in increasing the percentage of women entering the School of Computer Science from 7% in 1995 to 42% in the year 2000. The debate about serious gender-unbiased curriculum changes has yet to be opened.

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KEY TERMS

Covert Discrimination: (Usually negative) behavior manifested to make distinction based on some external characteristics of an object or person, usually in a negative way**.**

(Gender Defined) Horizontal Segregation: Can be understood as separation of women work force from the men in terms of the type of work which requires less technical skills**.**

(Gender Defined) Vertical Segregation: Separation of women work force in terms of low paying, low ranked jobs which involves relatively low decision-making powers in an organizational context.

Gender Divide: Can be defined as an unseen boundary that exists between men and women in terms of the overall differences in their attitudes, habits, preferences and interests.

Glass Ceiling: Following the definition of the Germany's Gender Research Group funded by the German federal government, the "glass ceiling" phenomenon is the invisible but nonetheless rigid barrier that blocks women's access to leading positions whereby women can advance in an organization, but only to a certain point, usually in middle-management, not to upper management or administrative roles.

Home Science: The study of home economics and the relation of the home to the community. It includes many aspects of domestic science, parental education, consumer education, and institutional management (food and nutrition science, clothing and textiles, household economics, hygiene, institutional management and dietetics).

Self-Efficacy: A measure of one's confidence in mastering new challenges. When self-efficacy is high, one believes a high probability exists that one will be successful; while low self-efficacy suggests a limited belief that one will be successful in accomplishing an objective.

Techno-Hazing: Refers to the bias that results from the assumption that women cannot be technically competent; and even when qualified, they are given jobs that lower complexity jobs or are supervised more closely.

A

Approaches to Conceptualising Gender

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INTRODUCTION

When people refer to gender issues in information systems, they draw on an implicit understanding of what this means, but may be unaware of the history of the concept of gender or the theoretical debates that surround its development. A thorough understanding of the conceptual and theoretical issues can, however, add much to the quality of research on the gender patterns that are observed in attitudes to and usage of information technologies and in organisational practices. Similarly, a good conceptual understanding will benefit those seeking to launch practical initiatives, including increasing women's access to and involvement with information technology. By building on the work of others, especially in the fields of psychology, sociology, women's studies, and political theory, information-systems researchers will avoid the conceptual pitfalls into which others have fallen.

The term gender usually refers to the socially acquired characteristics of men and women. It is distinguished from sex, which has come to be defined as biological characteristics. We now conventionally use the term gender as a variable in empirical research, although this is simply dichotomised into male or female and thus is really used as a proxy for sex. This distinction between sex and gender arose as a result of debates about gender issues in Western society generally, and with the development of feminist thought in the late 20th century, gender is now widely acknowledged as a key structural principle in society and as a topic of study in its own right (Chafetz, 1997; Tong, 1989; Weedon, 1999). In this article, we briefly discuss the issues underpinning the concept of gender and how this concept has developed.

BACKGROUND

The Rise of Gender as a Concept

Until the mid-20th century and the rise of feminism, gender was not the topic of serious academic discussion. In fact, the term was rarely used. Most traditional social theories simply assumed that conventionally understood differences between men's and women's experiences were the result of their respective innate characteristics and did not require any theoretical explanation. Traditional social theory accepted the view that men and women were natural categories with different behavioural and psychological dispositions (West & Zimmerman, 1987).

Public debates about women's roles gathered strength from the 1960s (second-wave feminism), and writers began to distinguish sex (the immutable biological component of human life) from gender (socially acquired characteristics of the two sexes; Eisenstein, 1984; Millett, 1971). This distinction focused attention on gender as the result of arbitrary and oppressive social practices and strengthened the critique of naturalistic or biological explanations. As social explanations for these phenomena gathered impetus, biologically based explanations were also more clearly articulated.

MAIN THRUST OF THE ARTICLE

Biologically Based Explanations of Gender

Biologically based explanations vary, but the most influential have come from sociobiology (Wilson, 1978) and its recent successor, evolutionary psychology (Pinker, 2002; Wright, 1994). Both approaches argue that evolutionary adaptation has led to behavioural differences between the sexes. Highly complex behaviours were attributed to evolutionary development rather than to social learning and social influences. Versions of these theories often find their way into explanations for behaviour in the popular media, typically to explain courtship, sexual, or reproductive behaviours. Biologically based explanations for the lower number of women in mathematics and computing argue that the sexes have different natural predispositions and innate skills. This approach does not recognise that this is a “complex and multi-faceted problem” with clear social forces at play (Gürer & Camp, 2002, p. 124). Such *biologically reductionist* explanations are, at base, ideological and are used to justify social inequalities (Montagu, 1980; Sayers, 1982).

Steven Jay Gould (2000) outlined a number of reasons why such biologically reductionist accounts are flawed. These include the following:

- The lack of evidence for biologically based claims (Connell, 1987; Fausto-Sterling, 1985; Greene, 2004; Montagu, 1980; Sayers, 1982). The variability of human behaviour within the sexes is simply too great, and the mechanisms by which sex chromosomes influence behaviour is too obscurely defined to explain complex human behaviour in biologically adaptationist terms.
- The inappropriate application of a biological evolution model to explain cultural change, which develops through diffusion, accommodation, and learning from others rather than through differentiation and selection.
- The a priori and consequently unscientific logic of biologically reductionist views. Such claims are not subjected to critical empirical testing or logical scrutiny.

Sex-Difference Research

The interest in identifying biological differences between men and women has persisted. Particularly within psychology, sex-difference research developed into a speciality (Bem, 1985). It has been subjected to strong methodological and theoretical criticism (Ashmore, 1990; Crawford, 1989; Maccoby & Jacklin, 1974). Underpinning much of the *sex-difference research* is the assumption that observed differences between the sexes are due to their innate dispositions. The social scientists’ job is to identify these differences and their causes. For example, girls and women are commonly believed to be more empathic, while boys and men are said to be more rational. This may be used to explain the reasons why fewer girls may take up IT; they are put off by the cold logic of technology (see Barnett & Rivers, 2004).

This approach can be criticised on a number of grounds. It has been very difficult to demonstrate empirically that differences between the sexes are significant (Ashmore, 1990; Crawford, 1989), and most differences cited are slight or trivial (e.g., ability to throw). Moreover, gender is too complex a phenomenon (culturally and historically) to be explained simply as an attribute of individuals. It may be more like a force acting on the individual than something within the individual. It has also been pointed out that sex-difference research does not adequately deal with motivations for maintaining and producing the current relations between the two genders. For example, how do we explain the resistance and hostility often expressed against women who enter nontraditional occupations such as IT (Foster, 1996)? As with biologically reductionist accounts, sex-difference research was accused of attempting to find differences in order to defend the social and political status quo (Ashmore).

Feminist Approaches to Gender

A body of scholarship emerged in the 1970s that took a critical approach to gender and sought both theoretical explanations for the social positions of men and women and a political strategy for addressing gender inequality. This field is described as feminist theory. Several strands of theory appear within the feminist tradition.

Some theorists saw gender differences as based entirely on the social shaping of individuals from infancy. People are taught to think and act in a particular way based on their physical sex characteristics. This sex role learning is seen to account for most of the observed behavioural differences between men and women. Gender socialisation (sometimes described as conditioning), in turn, limits the options of individuals. This approach highlights the importance of learning in the production of gendered behaviour and the arbitrary and changing nature of many gender traits, and it is related to different practices in educational institutions that subtly (or otherwise) encourage boys into appropriately masculine fields (e.g., mathematics) and girls into feminine fields (e.g., humanities and nurturing activities; Gilbert, Bravo, & Kearney, 2004).

Another strand of feminist theorists located the motivation for socially created gender differences in the political and economic sphere (see Barrett, 1980; Burton, 1985; Hartmann, 1981). By linking gender differences with the system of production, they argued that the underlying motivations for shaping the experiences of men and women differently included the ability to exploit women both as employees and as childbearers (Eisenstein, 1978).

In contrast to theories that minimised gender differences, some feminist writers emphasised the differences between men and women (see Connell, 1987, for a discussion). They argued that there are real differences that have been misinterpreted to the disadvantage of women. The origins of these differences were variously explained in terms of the parental division of labour (Chodorow, 1978), thinking and moral reasoning (Belenky, Clinchy, Goldberger, & Tarule, 1986; Gilligan, 1982), reproductive and sexual function (Firestone, 1972), and the distinctive social location of women (Collins, 1990). Others argued that women had a special (collective) understanding and sensibility arising out of their social location or standpoint (Harding, 2004; Hawkesworth, 1989).

Within information technology, this tradition can be seen in the work of Adam (1998), which seeks to transform information technology into more feminist understandings of technologies, sciences, and cultures rather than to seek to fit girls and women into the current masculine approaches. Women are seen to have a different perspective on the world that at once excludes them in the world, but on the other hand provides them with a special insight into that world and its alternatives.

Such views, sometimes described as radical feminism, are ultimately as *essentialist* as are those associated with sociobiology (Eisenstein, 1984). To be able to treat women as a universal and homogeneous category, it is necessary to identify just what it is that all women have in common. The problem is that within the category of woman is a diverse range of experiences that must be accounted for. It became recognised that neither women nor men are homogeneous social groups (Butler, 1990; see also West & Fenstermaker, 1995), and generalisations about sex groups are problematic.

Through three decades of research, theory building, and debate, it has been recognised that gender is an important social dimension and infinitely more complex than the simple dichotomies of man-woman and masculine-feminine encapsulate. Gender is not reducible to biological sex, and is not an essence or a set of core attributes of two mutually exclusive groups. This does not mean that gender is unimportant; there are real differences in outcomes in occupation, income, status, and life experiences for men and women. The theoretical challenge has been to develop a new approach to gender that recognises these differences but does not reduce them to biology or simple social conditioning.

Contemporary Approaches to Gender

West and Zimmerman (1987) and Butler (1990) independently developed similar approaches to this challenge. West and Zimmerman made an important distinction between sex, sex category, and gender.

- **Sex:** Sex is "a determination made through the application of socially agreed biological criteria for classifying persons as males or females" (West & Zimmerman, 1987, p. 127). What counts as male or female is not a given but the outcome of a social process. Certain attributes of the baby's anatomy are taken as indicators of the child's sex according to custom and science. We are placed at birth into one sex category or another. Subsequently, we relate to people not primarily on biological grounds, but on their "identificatory displays" (e.g., hair, clothing, bodily posture, and behaviour) that proclaim them as one sex or another. Sex category stands as a proxy for sex.
- **Gender:** Gender is the process by which one continuously demonstrates one's sex category (which may be either different from or the same as one's sex). It is the "activity of

> managing situated conduct in light of normative conceptions of attitudes and activities appropriate for one's sex category" (West & Zimmerman, 1987, p. 127). Gender is not something one is—some inner core or essence—but something one does in order to demonstrate membership in a sex category.

Butler (1990, 2004) similarly argues that gender is a style or act that has "no ontological status outside its performance" (p. 136). She posits gender as a set of performances, gestures, and enactments that produce the appearance of a gender essence, an essential "gender core." Gender is not a "stable identity," but is an "identity tenuously constituted in time" and "instituted in a stylized repetition of acts" (p. 140). Gender does not exist outside its enactment, and being male, for example, does not refer to some inner essence of maleness. Butler uses the term "performativity" to avoid implying that there is an underlying self or subject that directs the performances or enactments. Just as gender is produced through its enactment, so the subject, "the speaking 'I'," is formed as part of the production of gender. The fact that individuals are usually completely committed to their identification as males or females is a separate issue.

Gender as a concept has moved from being an assumed natural category to one in which gender is a process, an ongoing unfolding act that is continually shaped and refined. Gender behaviour is not informed by an inner core, biological or otherwise. It is informed by the mundane, everyday need to make sense to oneself and to others (West & Zimmerman, 1987). The "doing of gender" (West & Zimmerman) is not a trivial undertaking or easily displaced, but instead forms a framework in which the individual can understand himself or herself and others.

These formulations are known as practice or process theories of gender. On the one hand, they argue that the different attributes and behaviours of men and women are arbitrary and historical products. But they recognise that gender forms part of our very identity and understandings of the world, and they are no less real, nor less tenaciously held, as a result. Gender practices are socially constructed but nevertheless extremely difficult to change.

FUTURE TRENDS

The implication of this changing concept of gender for information systems is that we must recognise that the problem of gender imbalance in the discipline is both multifaceted and embedded within our identities, our social practices, and the social fabric. This, rather than biological factors, is why gender patterns in fields of study are seen as natural. The lack of change reflects not only an overdetermination of practices, but our constructions of our everyday practices. This suggests that any change is likely to be slow and difficult.

Those who want to explore gender phenomena in information systems will find value in postmodern feminist approaches that challenge both the naturalness of gender and the alternative: socially determinist explanations (e.g., Adam, 1998; Butler, 2004; Green & Adam, 2001). They will recognise that the technologies themselves are imbued with our gendered understandings. This will strengthen the objective of using research to help achieve greater involvement with information technology by girls and women.

CONCLUSION

In this article we have seen how the conceptualisation of sex and gender has developed since feminist scholarship raised both theoretical and social issues, and how different schools of thought have treated these concepts. The importance of gender has been acknowledged, and biological sex is less commonly invoked to explain behaviour. We are now less likely to see gender as an attribute and are inclined to recognise it as a process, both socially imagined and individually performed.

These new conceptualisations do not imply that gender as a social category or an individual identity is infinitely malleable or less real than biologically based sex. It cannot be readily engineered, discarded, or ignored (Shapiro, 1991). The challenge is to understand the substantial and ubiquitous nature of institutionalised gender patterns without suspending our critical ability to contest and alter them.

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KEY TERMS

Biological Reductionism: The attempt to reduce all significant human behaviour to biological and adaptationist causes, and more specifically, to attribute any significant differences in male and female behaviours to the different biological roles of males and females.

Essentialism: The belief that a particular group or set of elements shares a common and invariable thing, substance, or thread. Gender essentialism argues that women share different attributes, behaviours, and emotions that are intrinsic to women and that are not shared by men.

Gender: Definitions may range from an attempt to distinguish the socially acquired rather than biologically determined differences of men and women, to contemporary views that argue that gender is the process by which one continuously demonstrates one's membership to a sex category.

Sex: A determination made through the application of socially agreed biological criteria for classifying persons as males or females (West & Zimmerman, 1987).

Sex Categorisation: The placement of an individual into one categorisation or another. Sex categorisation may be independent of biological criteria.

Sex-Difference Research: An approach, centred in the discipline of psychology, to identify the psychological differences of men and women, and girls and boys.

Socialisation: A general process by which members of a society learn or are otherwise enculturated into the ways of the society. Different theories identify different mechanisms for socialisation.

Articulating ICT Use Narratives in Everyday Life

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INTRODUCTION

The most common definition of the information society lays emphasis upon spectacular technological innovation and the transformative effects of new information and communication technologies. The key idea is that breakthroughs in information processing, storage, and transmission have led to the application of information technology in virtually all, public and private, sectors of society (Webster, 1995). By the 1990s, to admire and indeed enthuse over new ICTs had become highly fashionable and popular. Such technological enthusiasm has become so pervasive that it has seeped not only into political and policy discourses, but also into the whole spectrum of the media and fora of public communication (Preston, 2001). In addition, discourses of the information society are often dominated and shaped by male commentators (e.g., Castells, 2000; Gates, 1995; Kelly, 1999; Negroponte, 1995). For example, when compiling a collection of the dominant players of international information-society discourse, Cawley and Trench (2004) were hard-pressed to find female commentators, succeeding only in finding 3 out of a total of 18 critics.[1]

We argue that the focus on the artefact, and thus technological celebration, takes precedence over the largely ignored field of technological uses and consumption issues. Hence, we present a study that analyses the individual user experiences to challenge the stereotypical user traditions represented by the information-society discourse. We wish to present a counternarrative that shifts the emphasis from technical expertise, and technological and transformative benefits of artefacts to more individual-user-focused narratives.

As a result, this brought about a dual-narrative process through which the respondents described their experiences. We found that when people described their uses, consumption patterns, and domestication[2] experiences of ICTs, they tended to do so by employing contrasting frames of reference. These frames of reference we have termed the objective lens (or narratives) and subjective lens (or narratives). Through what we term objective narratives, we found that some respondents would describe their use through official and technical frames of reference. For example, they employed primarily dominant information-society jargon to frame how they made sense of technologies and their use experiences. Through subjective narratives, we found that respondents would describe their use and experiences from primarily a personal perspective to explain how the technology fitted their lives, the role it played in their everyday routines and habits, and the associated meaning and significance of the artefact.

While these contrasting narratives are not mutually exclusive or contradictory, it became clear from the interviews that a pattern of use narratives was emerging. We found that such narratives slightly reinforced traditional gender roles in which men tend to talk about technologies in highly technical terms of reference, while women portray themselves as technologically helpless or ignorant (Gill & Grint, 1995; Gray, 1992; Lie, 1995). Although we did not look for or find stable gender categories, the emergent gender narratives seem to renew the existing gender roles that link masculinity and technology (Vehviläinen, 2002).

With the development of computer technologies, we have witnessed a shift from IT to ICTs. This has resulted in a redefinition of the computer as an artefact: from a mere computational device to the newly emergent multimedia-enhanced computers, or what Paul Mayer (1999, p. 1) calls a "metamedium." Today, the conceptualisation of the computer is more problematic. It may be thought of as the Web or Internet, computer games, CD-ROMs (compact disc read-only memory), reference works, e-mail, and a diverse range of applications for displaying and manipulating text, images, graphics, music, databases, and the like. Spilker and Sørenson (2000, p. 270) argue that computers are no longer "primarily about programming, systems, control and calculation," but instead "a gateway to communication and cultural activities." The shift in identity has opened up or unlocked the conceptualisation of the computer. Therefore, it is possible for wider audiences and previously excluded groups (such as the elderly and women) to translate the computer into something meaningful in their everyday lives. As a result, we were not solely focused on the computer as a separate technology, but instead on the wide range of information and communication technologies that are available in the domestic setting.

BACKGROUND

While the concepts of objectivity and subjectivity are not novel terms to describe contrasting positions, we have used the concepts to facilitate the understanding of how our respondents talk about their experiences and uses of ICTs. Orlikowski and Robey (1991) have employed this approach to address the relationship between information technology and the structuring of organisations. The authors argue that the essence of both social reality and ITs can be described by using objective and subjective perspectives. In Orlikowski and Robey's approach, the objectivist relationship to technology underlines the importance of the material characteristics of the artefact, while the subjectivist approach focuses on the importance of the subjective human experience in the interpretation, creation, and modification of the social world.

Although Giddens' (1976) theory of structuration bridged the gap between the objective and subjective social reality in academic circles, and in particular technology studies, the emphasis lies firmly in the objective approach (Orlikowski, 2000). We argue that one must consider both subjective and objective approaches to ICT discourse. The division is maintained in this article as it is constructive and valuable in the ways it enables us to discuss how and why the objective approach to articulating ICT use is publicised, overvalued, and hyperbolised. On the other hand, the subjective approach is often neglected and confined to private, domestic, and unofficial realms. The aim of this article is not to merely point to the existence of both discourses of ICT use, but instead to argue that it is important to locate the common ground between the discourses in order to provide a grounded and holistic picture of the ways people talk about their ICT use.

NARRATIVES OF ICT USE

The data for this article are drawn from a larger study of Finnish families looking at ICTs in everyday life and the use of electronic services.[3] The objective-subjective theme discussed here emerged while analysing the ways family members talked about their ICT use. For the purpose of this article, we draw on selective excerpts from the interviews to illustrate the contrasting narratives.

Pure Objective Lens

The dominant narrative of information-society discourse presents ICT use in a normative way, for example, by urging universal access and consumption, which is mirrored through official discourse in the ways everyday users express their personal experiences. This way of describing ICT use was also reproduced by several respondents, as can be observed in the following quote.

Ville: We had our first computer ... [it] was 2-8-6 ... quite interesting. We have it actually still somewhere; I don't know where.
Interviewer: Was it about when ... [W]ere you still in school?
Ville: Well, it was when [it] cost thirty grant[s] of old money.

Here, Ville was asked about his early memories of the family's first computer, and he replied listing only the technical particulars and the price of the machine. The quote gives an interesting insight into how male respondents often shied away from using personalised or subjective narratives to articulate their everyday use of or relationship with the artefact. Instead, they preferred to employ objective or dominant information-society narratives to describe their relationships with ICTs. We found male respondents would employ such narratives even when discussing Internet use.

Information-society discourse, as we stated earlier, adopts the classic determinist position whereby technical advances are celebrated using hyperbolic expressions (Preston, 2001). This technical enthusiasm is picked up by ordinary users (mostly male) who tend to reproduce these official narratives to describe their own use.

Pure Subjective Lens

We also identified another narrative used by the respondents to describe their use in a more personal or subjective fashion. To illustrate this alternative narrative, we present one example of a female respondent who expresses her use and consumption of the Internet by relating its use to her everyday routines and habits. Here we notice a shift in the respondents' narratives from objective discourses of use to narratives of personal and individual ways of describing how the artefact fits into everyday life.

[On the Internet] there is lot of instructions, people's gardens, advice. Then there is from these willow works. You find really those instructions, real illustrated, and they talk [on Web pages]. I just devour those. (Helena)

When talking about her use of the Internet, she gives very practical (or subjective) descriptions of her Internet habits, incorporating emotive and expressive language to articulate her use patterns: "and then I can manage without [the] machine [computer], but it is nice to visit [Web pages] if I just can."

She also makes it clear that using the Internet is not an overwhelming activity for her, but one she can do well without. This she explains partly due to the everyday situation in the family, as access to the computer is compromised due to other family members being active users.

Mixed Objective and Subjective Lens

Helena's husband Heikki gives us a very useful insight into the dilemma users face when trying to balance the objective and subjective relationships with the computer. He explains,

I don't really like [to] use it much then ... I don't know if it's character or what, but I feel bad if I'm not working; then when I'm by [the] computer ... I feel I'm wasting my time ... but I do sometimes [on] weekends. (Heikki)

In this quote, we get a sense of how users strive to reconcile the work-related or non-hobby-related uses of the computer and the Internet (objective) with the leisure or entertainment features and functions, and perhaps even communicative elements of ICTs (subjective). Objective discourses tend to focus on "worthy" or beneficial uses of ICTs while perhaps overlooking the everyday uses such as music downloading, game playing, surfing, and e-mailing. It is only through a subjective discourse analysis that we get a sense of the reality of everyday uses of ICTs and accordingly develop an understanding of the meanings and significance users assign to them.

TRADITIONALLY GENDERED OR GENDERED TRADITIONS?

This section will explore whether gender differences between masculine and feminine users are reinforced, reproduced, or challenged. Ostensibly, there existed some gender differences in describing one's own ICT use. It became apparent during the respondents' narrations that both men and women appeared to adhere to traditional gender stereotypes, in which men are presumed to be technologically oriented and women technologically helpless, or at least not interested in technology (Gill & Grint, 1995). In doing so, they do not just express their own interpretations, but they appear to also confirm and renew the connection between technology and masculinity.

However, on deeper analysis, we found some interesting similarities between the male and female approaches to describing ICT use. We suggest that the presence of such similarities can be argued perhaps as a weak indication that signals the diminishing traditional bond between technology and masculinity (Lie, 1995).

In our interview material, the men, Pekka, Heikki, and Ville, used all three narratives (objective, subjective, and mixed narratives). In spite of this, there also emerged some crucial differences between the men as Ville employed almost exclusively the objective narrative, even as he presented his individual ICT experiences. The other men, Heikki and Pekka, employed mixed narratives when articulating their ICT use. This reinforces the position held by Lie (1995), who argues that "the connection between technology and masculinity does not imply that all men are equally attached to technology, or that one can prove empirically that majority of them are" (p. 382).

Alternatively, the interviewed women, Paula, Helena, and Leena, employed subjective and mixed narratives. Significantly, they did not employ objective narratives at all. It became apparent that Leena was more aware of the objective discourse, but chose instead to articulate her ICT use in more subjective tones. Paula was quite enthusiastic about computer use and the potential benefits of the information society, using objective narratives to express her opinions. But when she described her individual role as an ICT user, she presented herself as "not the good and legitimate user," which can be seen as reverting back to subjective narratives. In essence, the female respondents knew of the dominant narrative of information-society discourse, but they used it as a mirror to present their own subjective experiences.

FUTURE TRENDS AND CONCLUSION

Although the objective lens continues to be used as the dominant narrative, we believe the subjective lens will become increasingly pervasive with more user- and consumer-focused research (such as Hartmann, 2003; Miller & Slater, 2000; Ward, 2003). This type of research mirrors the changing faces of ICTs from highly technical artefacts (bound up with programming and networking identities) to technologies with everyday uses for domestic users (with communicative and interactive functions). This shift brings about opportunities for ordinary users to articulate their own subjective relationships with ICTs while lessening the need for dedicated technical expertise and skills to operate information technologies. From a cultural- and media-studies perspective, Silverstone, Hirsch, and Morley (1994) view the "double articulation" of ICTs—both technological texts and media texts—as having an influence on relationships with ICTs, and in the case of this article, on the discourses people use to describe those relationships. As a result, ICTs are not solely studied from a technological perspective, as by computer scientists, but also from social and human-centred perspectives (e.g., Castells, 2000; Hine, 2000; Lie & Sørensen, 1996).

Furthermore, the scientific paradigm is recognising this shift as studies become less positivist in nature and instead focus more on areas such as interpretive studies (see Walsham, 1995, 2005). In the information-systems field, interpretive studies provide space to consider alternative explanations of ICT use and practice, in particular in new gender studies where the focus is not typified by the differences between the genders but instead on subjective differences, for example, between women's use of technology. Therefore, we suggest that the subjective analysis of technology use and its discourse should be considered a valuable insight into how users construct individual interpretations of ICTs. In cultural and media studies, the concept of domestication is employed to achieve insights into the experiences of individuals as they tame wild technologies and make them fit into their everyday surroundings, routines, and patterns. Domestication, as an analytical tool, gives scope to researchers to consider the technological and social characteristics of technology and the social factors that influence its use and identity. This approach to technology and everyday life marks a move away from the understanding that technologies appear in society ready to use, to an understanding of technologies as unfinished artefacts. It provides a very useful way of exploring the social complexity of how people experience ICTs beyond any simple idea of the benefits and uses of technology.

In conclusion, as ICTs become more a part of everyday life, we believe the stereotypical connection between technology and masculinity will focus less on male users and female nonusers, but will focus more accurately on the kinds of uses there are and how those uses are articulated. We posit the technology-orientated male will be replaced, for example, by the sophisticated image and narrative of the open-source programmer, with all the superfluities of high technical expertise. Meanwhile, the technologically helpless female is interchangeable with representations of unsophisticated use or everyday uses of information and communication technologies.

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INTERVIEWS

The interviews conducted in South Ostrobothnia, Finland. Names of the interviewees have been changed:

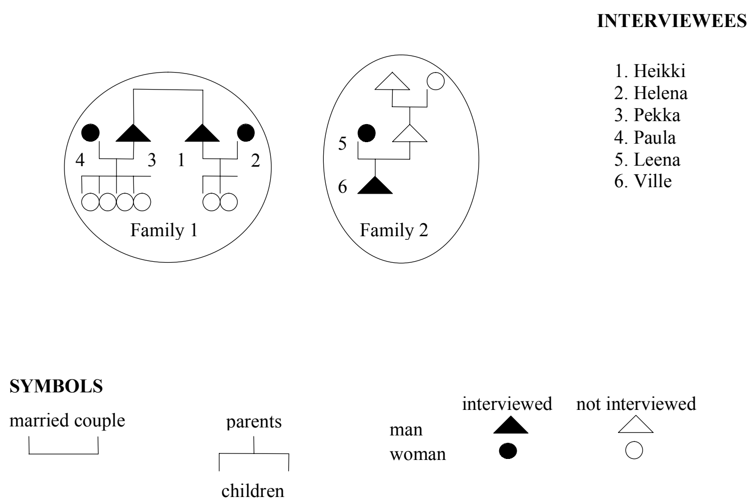
Heikki, interviewed June 2, 2003, by E.-R. Koivunen
Helena, interviewed June 2, 2003, by M.-K. Paakki
Leena, interviewed June 24, 2003, by M.-K. Paakki
Paula, interviewed July 16, 2003, by M.-K. Paakki
Pekka, interviewed July 16, 2003, by E.-R. Koivunen
Ville, interviewed June 25, 2003, by E.-R. Koivunen

APPENDIX

Two of the project members, researchers Koivunen and Paakki, collected the empirical material and interviewed the respondents in the summer of 2003. The interviews were conducted in a South Ostrobothian village in Finland. In the village, there are 400 inhabitants, a school, a shop, a bank, and a church. The interviewees are members of two extended families (see Figure 1).

Family 1 is comprised of the households of two brothers and their families living next to each other. The brothers, for whom we use the pseudonyms

Figure 1. The interviewees and their family relations



Heikki and Pekka, are both married and have young children. Heikki and Helena have two daughters, while Pekka and Paula have four daughters. In these families, all members use the computer and the Internet. We interviewed the brothers and their wives. These interviews took place at their homes.

Family 2 includes a grandmother, grandfather, father, mother Leena, and a 20-year-old son, Ville. They all live on the family farm. From this family, we interviewed only the mother and the son, who are both known in the village as active and innovative users of ICTs. The other members of the family do not use the computer or Internet. Leena was interviewed at her workplace, which she called her second home, while Ville was interviewed at home.

KEY TERMS

Domestication: Domestication refers to the process whereby technological artefacts are fitted into the routines and practices of the everyday lives of users. It is a process whereby technologies are consumed within specific and localised contexts and become inscribed with meanings, while reproducing values and transforming relations.

Dominant Narratives: Dominant narratives are part of our shared cultural knowledge about standards, which we refer to in explaining our acting, knowing, and thinking, and they are produced and reproduced in the discourses of everyday life.

Double Articulation: Double articulation refers to the concept that media lead double lives as both communication media and artefacts. Technologies are doubly articulated in the ways we need to address responses to particular texts or genres brought to us by the media and, on the other hand, the significance of media technologies themselves.

ICTs: Information and communication technologies such as televisions, telephones, the Internet, computers, and so forth.

Information Society: This concept is characterised by a new kind of information-led, service-oriented society that will replace the industrial-based model that had been dominant in the West in the 19th and 20th centuries. Information, and those who know how to create, assemble, and disperse it, is deemed more valued than labour.

Objective: The objective is nonsituated, impersonal, and not dependent on or influenced by personal opinions or prejudices.

Subjective: The subjective is based on thoughts or feelings derived from individual experiences and personal interpretations.

ENDNOTES

1. Those female commentators are Sherry Turkle, Esther Dyson, and Robin Mansell.
2. Domestication here refers to the process of rendering new technologies as tame as they enter the domestic setting.
3. See Appendix for an extended account of the empirical data sample.

Attitudes Towards ICT in Australian High Schools

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INTRODUCTION

Information and communication technology (ICT) is integrated into almost every daily activity. Yet, few females today are choosing ICT based careers; a large percentage prefer to work in "pink collar" jobs such as childcare, education, and nursing. A recent report (Queensland Government, 2004) states that the average weekly earnings of full-time female workers in ICT, personal services, education, and health careers are $883.30, $513.10, $802, and $854.20 respectively. Furthermore, even though females consistently earn less than males, female ICT workers record the highest average earnings for all female occupations. Not only are females rejecting the financial rewards associated with ICT careers in favor of jobs that are seen to have a high human concern, they are also denying their voice in the creation and development of future technologies and applications. However, why are they shunning ICT study and careers? How does their educational environment and their perceptions of ICT impact ICT study and career choices? This article explores these questions through the 2003 case study of Year 9 and 12 students, teachers and guidance officers at two co-educational schools in Queensland, Australia. Data was collected from 490 participants through questionnaires and six students and four teachers took part in interviews. Two theoretical frameworks, organizational culture and information quality, were used as a lens to view the situation.

BACKGROUND

The longstanding debate over whether females are not engaging in ICT careers because they are biologically not suited to technical work (essentialism), or that they have been nurtured to believe that they are not suited to technical work (social construction), continues to be contested. However, new theories, including Trauth's (2002) theory of individual differences, are emerging to address the flaws and gaps within these theories. The underrepresentation of females in ICT is also not a global phenomenon; there are cultural pockets in the world, including Mauritius, where females represent a relatively equal proportion of the ICT vocational and educational cohort (Adams, Bauer, & Baichoo, 2003). However, it is a well-documented problem in Western cultures, including Australia.

Research shows that females are methodically guided away from technical fields during school through classroom culture, traditional gender roles and other societal pressures (Gorski, 2002). Some of the enduring ICT stereotypes are that ICT professionals are Caucasian males with antisocial tendencies (Countryman, Feldman, Kekelis, & Spertus, 2002; Gürer & Camp, 2002) and that ICT is boring and "geeky" and involves working long hours in social isolation, (Joshi & Kuhn, 2001; Myers & Beise, 2001; Newmarch, Taylor-Steele, & Cumpston, 2000). Popular media has enabled mass reinforcement of these established and often undesirable ICT stereotypes and there is a distinct lack of both fictional and real ICT role models who are given media coverage (Multimedia Victoria, 2001). Job security is also important to senior school students (Multimedia Victoria, 2004). Today's youth witnessed the "dot-com" boom and skills shortage followed by mass redundancies and unemployment in ICT during the bust. This episode was highly publicized by the mass media, but the recovering ICT job market has not been given the same level of publicity. According to the Oliver Group director, the technology sector grew almost 56% in the twelve months from March 2004 (Foreshew, 2005). Anecdotally, many students and their parents believe that the ICT job market is still depressed and express surprise when informed about the recovering market.

Many students lack information about ICT work and exhibit little understanding of the nature of ICT jobs (von Hellens, Nielsen, & Beekhuyzen, 2004). They do not know about established ICT occupational roles, such as being a computer scientist, let alone the new opportunities that are being created and thus do not know how their talents and skills apply in that field (Jepson & Peri, 2002). However, describing the ICT area, including job roles and areas is a non trivial exercise, even for experts in the area (Spencer, 2003). Australian students are also receiving limited information about ICT subjects and choices available to them (Van Der Vyver, Crabb, & Lane, 2004). Students have been exposed to ICT integrated into the general school curriculum, but few have a clear idea of what is involved in ICT subjects (Sheard, Lowe, & Markham, 2001). Compounding the issue within vocational education, career advisors often admit to struggling to understand ICT jargon and job descriptions (Standley & Stroombergen, 2001) leading to the lack of confidence in giving ICT career advice (Multimedia Victoria, 2001).

The way that the ICT curriculum is introduced and the learning environment impacts on the ICT attitudes of students is of high concern. It is imperative that the curriculum provides future ICT students with coursework which interests both sexes whilst providing them with the appropriate skills to enter ICT career paths (Gürer & Camp, 2002). Yet, many students report negative opinions of ICT specific subjects and general dissatisfaction with the ICT curriculum (Carey, 2001; Multimedia Victoria, 2001). These opinions could be partially because the predominant content of ICT subjects in schools involve word processing and spreadsheets (Downes, 2004) providing the students with a skewed perception of the true nature of ICT careers (Multimedia Victoria, 2001). ICT educators must not only focus on good teaching, but they must also evaluate whether the subject is seen to be challenging, useful and interesting (Mitchell, Sheard, & Markham, 2000). The ICT learning environment has a number of unique features including a predominantly male teaching cohort, who usually have a science or mathematical background, and a curriculum and associated assessment and exercises driven largely by masculine interests (Logan, 2004). Also, according to Carey (2001), teachers presently receive little or no training in the ways that technology can be used to create an equitable, innovative and engaging learning environment.

IMPACTS ON ICT PERCEPTIONS

Organizational Culture

Culture is the product of a social environment and evolves through the course of social interaction (Hofstede, 1997, p. 5; Morgan, 1998, p. 130). Cultural influences can shape perceptions about ICT, how ICT is used, and in turn the potential entrants to vocational and occupational areas in ICT and related fields (Harris & Wilkinson, 2004). Allaire and Firsirotu (1984) created a conceptual framework to assist in the analysis of organizational culture that consists of three inter-related components: a cultural system; a socio-structural system; and the individual actors.

The cultural system is a system of shared and meaningful symbols, which is shaped by its surrounding society and organizational history (Allaire & Firsirotu, 1984). There were a number of symbolic artifacts specific to ICTs that were observed amongst the responses from teachers and students, including terminology such as "hacker," "geek", "nerd," and "square" when talking about ICT workers. The students linked ICT success with these symbolic artifacts when 24% of Year 9 students and 41% of Year 12 students stated that it was necessary to be nerdy/geeky to be successful in ICT careers. However, these symbolic artifacts are commonly used in a negative social context and tend to deter students from engaging in activities that would have them labeled as such. Other common beliefs repeated in teacher comments were that computers are seen as toys for boys and tools for girls. Female teachers also identified with these beliefs and one commented: "[computers are] strictly a tool to be used, not to be aspired to." If computers are continually portrayed as something serious, rather than enjoyable, this may explain the reluctance of students to become involved in ICT. Students and teachers often regarded ICT subjects as being difficult with some students rejecting ICT subjects out of concern for their academic results and university entrance scores.

The socio-structural system consists of management strategies and policies and formal structures (Allaire & Firsirotu, 1984). All schools must comply to a certain level, with standardizing educational policies of the government, but the way that the curriculum is developed and delivered can affect the way in which the subject is viewed. The cost of providing and maintaining ICT resources and infrastructure is an issue and the lack of financial and physical resources affects the delivery of the ICT curriculum and how it is (negatively) perceived by the students and teachers. One teacher also felt that if a student was ICT inclined then that they would find alternative ICT resources outside of the school. Yet, in low socio-economic areas, many families still do not have access to computers at home and rely on schools and libraries to provide those resources. Many teachers and students complained about the quality and quantity of resources available, with only 25% of teachers at one school saying departmental budgets allowed the purchasing of adequate resources to deliver the curriculum. Teachers also commented that students sometimes cause further damage to broken computers out of frustration or boredom.

Personnel, classroom availability, and timetabling were other ICT resource issues that caused tension. Students were foregoing ICT subjects because of timetabling conflicts saying that "[ICT subjects] have to be sacrificed to fit other first priority subjects in." Teachers also identified that ICT subjects were the most time consuming to prepare for. "It needs more preparation time because things change so rapidly … I could go back to teaching chemistry tomorrow and yes, the syllabus has changed fractionally, but the basic chemistry hasn't changed in 50 years and the level we teach at high school won't change." Another teacher also conceded that it was difficult to foster and maintain student interest in relation to ICT saying, "it's hard to interest them because they have computers and the Internet at home."

Individual actors bring their own experience, personality and legacy to an organization and depending on their status can contribute and mold reality (Allaire & Firsirotu, 1984). Students have their own motives in relation to whether or not they enroll in ICT study and factors influencing these motives include enjoyment of the area, career aspirations, and opinions of friends, family, and role models. When students were asked what influenced their career decisions, the top responses included family and friends, but also high on the list was TV shows. Most students found that ICT subjects were boring, but others planned to combine ICT with other interests: " … this is a way of doing music and technology at the same time." When students were asked about the most appealing factors for an ideal career, the top response was interesting work followed by high salary and working with/meeting other people. These factors recognize social, remuneration and lifestyle aspects of future careers and are generally opposite to what ICT is perceived to involve.

Information Quality

Individuals often have differing opinions, wants and needs, and as such, each individual's definition of quality may vary significantly (Garvin, 1984). Schools are required to teach a certain amount of core information, but the way that this information is taught will differ between different schools and teachers. A teacher reiterated this when asked whether the ICT curriculum prepares students for ICT careers: "Depends which school." Some schools do not offer compulsory foundation ICT subjects in Year 8, whilst others do. Consequently, students who need to make informed decisions about subject selections in Year 9 and 11 may be disadvantaged at schools who do not offer these foundation subjects. Students also recognized the impact of foundation subjects on subject decisions in senior high school. Comments included: "in Year 9 we do Web pages and in Year 10 we do programming and that whole last semester of programming is like an introduction to IPT [a senior ICT subject]" and "you do math from Grade 1, but you don't do computer programming from Grade 1; you don't know what you are walking into."

Teachers are expected by society to have a wide range of knowledge, skills, and ability in their area of teaching. However, the rapid changes in ICT create problems for ICT teachers. Teachers also recognized the need for qualified ICT teaching staff. One teacher also told of his entry into the ICT classroom: "I arrived in my second school as a third year teacher and the computer teacher had gone away on leave for 6 or 12 months and they said, 'you're young, here is the computer room, you are teaching the class tomorrow' … and that was my first introduction to computers." ICT teachers also recognized that the ICT curriculum was dated and lacked relevancy, possibly because of the limitations of subject texts. One teacher also commented that the senior ICT subject "is too narrow a context for the modern use of computers … " Students also expressed general dissatisfaction with the ICT curriculum saying that it was boring and that theory outweighed the practical work. Another problem with ICT subjects in high school is that they are not a prerequisite for tertiary ICT study. Teachers and guidance officers also face difficulties with is the changing job roles in ICTs. As advisors, if they are not well informed, it is difficult to understand how they could give accurate, current, and reliable ICT career information to the students. Who is educating the students about their ICT career options?

FUTURE TRENDS

Investigation into the declining number of females entering ICT study and career paths has been underway for over two decades. Today, we are no closer to finding a solution to this problem, as we were twenty years ago. In fact, the decline of females entering ICT tertiary education is becoming worse over time. Previous studies, including this one, have investigated various points of view and factors that may influence female ICT career decisions. Some of the factors identified include national and organizational culture, lack of or poor quality ICT career information, societal influences, discriminatory work environments, practices and policies along with the need for appropriate ICT role models. Another complicating factor is that the world and the ICT industry are not static. If you add to this volatile mixture, the changing and individual needs of the girls, the puzzle becomes increasingly complex. While these studies have contributed by identifying these issues and making recommendations for change, some which have been instituted, this complex social problem has not been solved.

These factors, however, cannot be looked at in isolation. All things being equal, it would be expected that girls who are given the same information and experience the same social and cultural values and information, would have similar career goals and paths. However, this is not the case. Could it be that we are concentrating on the negativity of this problem rather than celebrating the positive outcomes that already have been achieved? Perhaps researchers in this area need to reverse the question and ask the individual girls already enrolled in ICT subjects and careers, what drew them to the area and what drives them to achieve and succeed. Additionally, individual personalities and academic abilities cannot be disregarded when investigating career choices and the declining female ICT cohort. Individuals have distinct personal likes and dislikes; it has to be remembered that some females, and males for that matter, will never find ICT interesting, and it is an exercise in futility, to change them.

CONCLUSION

Although the ICT industry is known for its cyclic nature, people working in it are generally well remunerated and seen as being in a position of power and status because of the enormous role that ICT plays in business and everyday life. These benefits of working in the ICT industry, along with having a voice in the design and use of ICT, can impact positively on the quality of life and the lifestyles that women and their families experience. This study found that Australian girls are continuing to reject ICT careers partially due to negative perceptions and stereotypes. There also is a lack of adequate resources and trained ICT teachers passionate about teaching ICT, and students are frequently rejecting ICT subjects because they are seen as dull, boring and not meeting their needs. They are also rejecting the opportunity to work in ICT careers because of school experiences, the lack of accurate, meaningful, and timely ICT career information and positive role models. Finally, the influence of popular media on career decisions is an important area that should be exploited. Perhaps, in the future we may see shows about sophisticated and powerful women in ICT careers leading to increased ICT interest. We can only try.

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KEY TERMS

Essentialism: The belief that traits are biologically determined and do not vary between individuals or genders.

Guidance Officer: A person whose role in a high school is to assist students with career information and guidance, assess students with special needs and provide students with support and personal counseling.

ICT: Information and communication technology is a broad grouping of technologies which include IT and telecommunications. Areas incorporated include computer science, software development, the study of organizations and society, mobile telephony and networks.

ICT Role Model: A person who has an interest, background, or career in ICTs whose behavior, attitude, or achievements make them worthy to be admired or imitated.

Pink Collar Jobs: Jobs that generally have a female dominated workforce such as: nursing, cleaning, childcare, primary school teaching.

Social Construction: Hypothesizes about the way that we analyze and categorize our experiences that influence and form our understanding of reality in our own social context.

Symbolic Artifacts: A way of making things known by signs and symbols which can include language.

Australian IT Enrollment Trends and Model of Contributing Factors

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INTRODUCTION

Australia, like other western nations, is experiencing a *downturn* in overall *enrollments in higher education information technology (IT) degree courses* as well as in the proportion of females selecting these courses. The percentage of women enrolled at a university in Australia, as a proportion of all enrolments, has increased steadily over the last decade from 52% of the total student body in 1993, to 54% in 2003 (DEST, 2004). This increasing number of females on campus is not reflected in *IT degree course enrollments*, where the number of female commencing students is steadily declining.

BACKGROUND

In Australian universities, IT courses cover a range of specialties: information systems, computing, computer science, software engineering, computer graphics, and database management are some example titles. The many names associated with the discipline, its relatively new nature, and the continuing growth in its application into new fields may account for this range of university courses offered in the discipline. The broad classification provided by the associated government department that gathers statistics divides the discipline into thirteen areas, which have been grouped in to four main categories for the purpose of this article: computer science, information systems, information technology, and information technology not elsewhere classified[1]. Figure 1 clearly shows the declining popularity of all IT courses with young women.

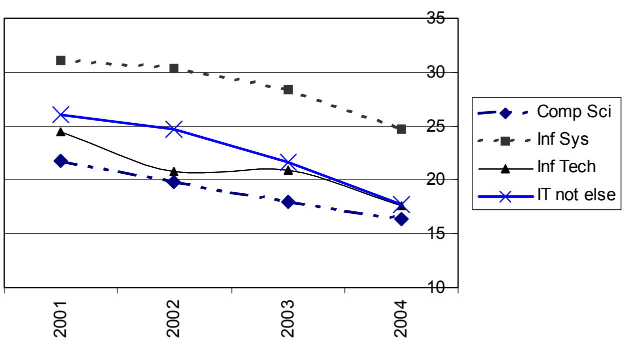
The downturn in popularity of IT degree courses is also evident in statistics related to student selection of university courses. Since 2001, there has been a decline of 46% in the number of students choosing IT as their first preference university course (VTAC, 2004). Divided by gender, there is an overall decline of IT course popularity of 65% in females and 40% in males (VTAC, 2004). This trend of declining popularity of IT degree courses is against the trend of young women embracing university education in general.

This apparent under representation of women in IT raises two questions. Why is the under representation an issue and why is there an under representation? An examination of the literature in this field and further discussion of these two questions is covered in the next section of this article.

WHY FEMALE UNDER REPRESENTATION IS AN ISSUE

A primary concern of IT academics and IT professionals as a result of the under representation and apparent declining interest in IT courses amongst

Figure 1. Female commencing students as % of total commencing students (within IT streams)



women is that the pool of talent being attracted to this discipline is not diverse enough and there is a "latent IQ" being overlooked (Richardson, 2003). The discipline is poorer because the under-utilisation of women results in a lack of the female perspective being reflected in IT projects in general (Richardson, 2003). Arguably women are excluding themselves, or being subtly excluded by social norms, from the opportunity to influence and shape future applications of IT in business, health, industry and education through not being involved in its design and application to an equivalent extent as men. The international women and computing literature expressing this concern can be traced back over twenty years, and provides information of government, education and industry funded programs to attract females to the discipline since the 1980s (Craig, Fisher, Scollary, & Singh, 1998; Wardle & Burton, 2002).

WHY THERE IS FEMALE UNDER REPRESENTATION

Efforts and intervention programs to attract women to IT appear to have had limited success and often negligible impact beyond the local area. Some programs implemented at secondary and tertiary levels in Australia and overseas have produced increases in enrolment numbers (Jewell & Maltby, 2002; Margolis & Fisher, 2002), but have not led to increases in the enrolment statistics in Australia in general. One particular study at a Victorian university found that a government funded Australia wide program initiated in 1990 to attract and retain women in IT fell well short of its aim of 40% female enrolments in higher education IT degree programs by 1995 (Byrne & Staehr, 2003). At the Australian Women in Computing conference in 1997, a collection of data from participating institutions showed that only two universities had met the government target of 40% female participation in only two of their degree programs (Byrne & Staehr, 2003).

The explanations given for this under representation will be discussed in the following sections. They have been logically grouped to provide a hierarchal overview of the extent of their influence. Overriding all is culture, which influences family, then education experiences, and last of all, the individual.

Culture

An overview of the cross cultural aspects of gender and IT is provided by Galpin who uses the "internal self-selection" model to explain why the lack of females in science in the U.S. cannot be applied to countries like India for example, where the family and not the individual is the decision maker (Galpin, 2002). While there is no evident pattern across countries, the expected role for females in the society, who the main decision makers in the family are, religious beliefs and education opportunities of females vary between cultures and all influence the decision to pursue a science or IT career (Galpin, 2002). An earlier study found that Asian women are less discriminated against and encouraged more by parents to follow career paths in IT (Clark & Teague, 1994). Preliminary results of a study across three countries (Australia, Hong Kong, and England) found a common perception of the IT discipline (male, isolated) held by both genders. This perception, rather than perceived academic difficulty, was the main reason given by participants for not choosing an IT career path (Craig, Paradis, & Turner, 2002).

Nielson, von Hellens, Greenhill, and Pringle developed a useful diagram that summarised factors affecting student perception of IT careers (1998). They included the key factors of gender, life history and cultural values that were influenced strongly by cultures of collectivism and cooperation (an aspect of Eastern cultures) or individualism and competition (an aspect of Western cultures). They concluded that national culture appeared to strongly influence perceptions of IT, more strongly than gender factors (Nielson et al., 1998). The strength of influence however cannot be measured and with the evidence in enrolments of fewer western females studying IT than females from Eastern cultures, the influence of culture appears quite strong.

Family

Family expectations are intertwined with culture and are a contributing influence to account for why women choose to study IT. The education level of parents influences whether girls decide on engineering, science or computing career path. This seems to be more applicable to females than males and the education level of the mother tends to be more influential in this decision that that of the father (Gayle, Berridge, & Davis, 2000). If the parents were also engaged in science and engineering the probability of child majoring in this area is increased (Leslie, McClure, & Oaxaca, 1998).

In families where there are high expectations placed on females to get an education and pursue a career, there is also typically existence of family friendly workplace policies, including a high level of provision of affordable childcare places and flexible working hours. Israel and some Mediterranean countries have family friendly societies (Galpin, 2002) where crèches and flexible working hours are provided to allow females to be equal contributors to the workforce. Before unification East Germany had over 90% of females in the workforce and a healthy 58% in IT (Oechtring & Behnke, 1995) and all workplaces provided crèches. Since unification the number of females in the workforce is less and the number of females in IT had declined to 9.5% (Oechtring & Behnke, 1995). While this decline cannot solely be attributed to childcare provision, the reduced support for females in the workplace is a contributing factor.

Arguably the economic situation of a family influences whether girls choose to study an IT degree or not. It can be surmised that the economic stability of the family directly influences whether a higher education degree for a daughter is feasible or not.

Education

The educational climate of the secondary school can strongly influence the expectation and feelings of self-efficacy students experience towards maths and technical subjects like IT (Bandura, 1997). According to Bandura (1997), as children master cognitive skills at school, they develop a growing sense of their intellectual efficacy. Cooperative structures in which students encourage and teach one another generally promote higher performance attainments than do competitive or individualistic ones (Bandura, 1997). Perceptions of self-efficacy have a direct effect on student choices in educational fields. According to Reeve (1996), students seek out situations that they judge themselves as capable of handling.

Experiences and opportunities in education also influence females' feelings of confidence when dealing with computers. Huff writes about the effect of "situational stress" on females and males (Huff, 2002). This is the effect of using a computer in a public setting, which negatively impacts on females to a greater degree than males (Huff, 2002). Unfortunately, computing and IT classes are often "bastions of poor pedagogy" (Margolis & Fisher, 2002). Many girls have commented on the intimidation they feel by being a minority in IT classes (Lang, 1999; Margolis & Fisher, 2002; Spertus, 1991) and the negative effect this has had on participation in classes. An encouraging and cooperative environment in secondary school, be it girls only classes or otherwise, is more likely to build an interest in IT than an individual and competitive environment.

The Individual

A common thread in successful IT programs initiated to attract women to the discipline is that personalised contact and on-going support is required (Clayton & Lynch, 2002; Jewell & Maltby, 2001; Margolis & Fisher, 2002). The basic premise that females need to be encouraged to persist in a male dominated field is reiterated by Townsend who purports that if the average female is to be given the same chance as the average male, there is still a need to counteract the unequal technical socialization that males get, in particular from the computer games market (Townsend, 2002).

Trauth's (2002) theory of individual differences employed empirical data to theorize the relationship between the social shaping of IT and gender identity. She explored "the way in which social shaping of gender and the IT profession operates at an individual level" (Trauth, 2002, p. 103). This theory has the underlying assumption that "inherent IT capability and interest spans the gender continuum" (Trauth, 2002, p. 104). Trauth emphasised the lack of cross-cultural identification with what is male and what is female in the research to date. "There are as many different 'women's experiences' as there are types of women" (Trauth, 2002, p. 102). Her study explored how the IT profession operates at an individual level. The individual differences theory is an extension of the argument that individual differences are a product of gender and socialisation within and between cultures. This theory is added to and extended in the model of contributing factors presented in the next section.

Figure 2. Model of contributing factors

The Individual	*Self-efficacy; ability to withstand implications that individual may not meet society's expectation of a female; ability to work in an occupation where they are a minority.*
Education	*Pre-school, primary, secondary, and tertiary educational experiences and opportunities.*
Family	*Influenced by culture; parental expectations; education experiences. Economic situation of the family is directly relevant to opportunities presented.*
Culture	*The root of it all. Where does culture place females in society? What role is expected of them?*

MODEL OF CONTRIBUTING FACTORS

The preceding model represents the layering of factors that contribute to the decision to study an IT degree course. It draws on the individual differences theory, and adds to it the influence of education, supported in the literature. Many aspects interact and build upon each other to influence the type of woman who will choose an IT career path. The model emphasises the base of culture and the overlays of family expectations, educational experiences and individual characteristics that will influence whether a woman chooses an IT career path or not.

To test the model of contributing factors a pilot electronic survey was carried out on female students enrolled in an IT degree at an Australian university. The aim was to determine if these students had commonalities in culture, family expectations, and educational background and whether or not these factors influenced their decision to study IT courses. Questions were designed to determine if there were patterns in prior education, (single sex school attendance, previous mathematics and science education) and family expectations (position in family, education level of parents, siblings already in university). Students were asked to indicate their familiarity with computers (at what age did they start using them, personal knowledge of a computing professional). The survey was created using specific software to allow for anonymity and made available via a secure Web-server. The URL for the survey was mailed to all currently enrolled students in four IT degrees. The survey was open for one month only. The response rate was 15%, but considering the time frame chosen for the administration of the survey (during the examination period) this rate is considered acceptable. This pilot study will provide a framework for a much larger survey, across the whole university, in the coming year. The results of the pilot survey with future relevance will be discussed in more detail in the next section.

FUTURE TRENDS

There are some emergent trends in relation to culture, family expectations, and educational background. The results of the questions to determine cultural background indicate that, in this sample, only half the students completed their final year of secondary school education in Australia which indicated that half the respondents were overseas students or very recent migrants to Australia. Given Australia's location in the world, it is not surprising to see that slightly more than half reported their cultural background as Asian (53%). Australia is considered a multi-cultural society, and this is reflected in the places of birth of these students. Only 40% were born in Australia. The emergent trend of half the students being Asian supports the individual difference theory of the culture of "collectivism" overriding individualism when choosing career paths (Neilson et al, 1998). IT is considered to operate at a particularly individual level (Trauth, 2000) and arguably, these results indicate that the collective nature of Asian family culture influences student career choice and overrides individual preferences and differences.

Family expectations are influenced by the culture in which the family live. The parents of more than two-thirds of these students were educated beyond secondary school (66% fathers and 77% mothers with 72% of the students having one or more parents who hold bachelor degrees). On closer inspection, the survey responses show that these students are the daughters of engineers, doctors, and education professionals (46% mothers, 57% fathers). They generally come from households where both parents work (85%). Two-thirds of the respondents are the first among their siblings to attend university (half of them are the oldest or only child) and 74% reported that their family had strong expectations of them attending university. The emergent trend is of high family expectations influencing career choices of these students, and supports the earlier findings that technically educated parents strongly influence the career paths of their daughters. It can also be surmised that the economic situation of the family has an influence, with the majority of families having both parents in the workforce.

The majority of students in this sample completed mathematics to the final year of their secondary school (92%), two thirds also completed science subjects, and IT subjects to final years of secondary school. They are computer literate, with 78% using computers before or during junior secondary school years. This could be a reflection on the self-efficacy of the students in relation to their education experiences, and that the math and technically capable students are choosing IT courses. To establish if this pattern is significant the survey will be widened in 2005 to determine the profile of students in other disciplines and to see if males fit the same profile as females in IT.

CONCLUSION

Educators are aware that there is no simple way to increase female participation in IT. The issue is multi-faceted, and despite over 25 years of intervention programs, the declining enrolments of women in IT are still a major issue. This article has provided a statistical overview of trends in higher education IT enrolments in Australia in the first few years of the 21st century. A model of influences has been tested against a small sample of current females enrolled in IT to determine if it is effective. This model adds the feature of educational experiences and gives this more prominence in influencing student career choice than earlier models. Some trends have emerged that need further investigation with a wider study.

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KEY TERMS

Collectivism: Society culture that favours group decision making, group well-being and group progression over individuals.

Database Management: Creation and maintenance of an electronic database system.

Gender Continuum: Movable division between male and female genders.

Individualism: Society culture that promote ego and self beyond group culture.

Knowledge Poor: Lacking resources or facilities to access information.

Knowledge Rich: Having a plethora of resources available to access information.

Latent IQ: Potential knowledge not presently available.

Self-Efficacy: Belief that one is able to succeed in a given area.

Software Engineering: A systematic approach to the analysis, design, implementation, and maintenance of software.

Technical Socialization: Opportunity and resources available to enable familiarization with computer hardware and software.

ENDNOTE

[1] For the purpose of this paper DEST classifications for the broad field of study Information Technology have been used. They have been grouped by the authors as follows:

- Computer Science (020100 Computer Science; 020101 Formal Language Theory; 020103 Programming; 020105 Computational Theory; 020111 Data Structures; 020113 Networks and Communications; 020115 Computer Graphics; 020119 Artificial Intelligence; 020199 Computer Science not elsewhere classified)
- Information Systems (020300 Information Systems; 020301 Conceptual Modelling; 020303 Database Management; 020305 Systems Analysis and Design; 020307 Decision Support Systems; 020399 Information Systems not elsewhere classified)
- Information Technology (020000)
- Information Technology not elsewhere classified (029900 Other Information Technology; 029901 Security Science;029999 Information Technology not elsewhere classified)

The Beijing World Conference on Women, ICT Policy, and Gender

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INTRODUCTION

The 1995 Fourth World Conference on Women, Beijing, China, addressed gender equality issues in many areas of global society, including information, communication, and knowledge exchange and the associated technologies. The Beijing Declaration called for action to promote gender equality in human rights, economic autonomy, domestic responsibility sharing, participation in public life and decision making, access to health services and education, and the eradication of poverty and all forms of violence against women. The Beijing Platform for Action contained strategic objectives and actions for governments and others to implement to increase gender equality in 12 critical areas, including Section J, Women and the Media. Article 234 of the Beijing Platform Section J acknowledged the important need for gender equality in information and communication technology:

advances in information technology have facilitated a global network of communications that transcends national boundaries and has an impact on public policy, private attitudes and behaviour, especially of children and young adults. Everywhere the potential exists for the media to make a far greater contribution to the advancement of women. (United Nations [UN], 1995, p. 133)

Section J defined two strategic objectives that address issues of access to and participation in ICT and media development.

J.1. Increase the participation and access of women to expression and decision making in and through the media and new technologies of communication.

J.2. Promote a balanced and nonstereotyped portrayal of women in the media. (United Nations, 1995, pp. 133-136)

Governments agreed to implement the Beijing Platform for Action and use gender-disaggregated data to report national progress on objectives during Beijing +5 United Nations General Assembly Special Session (UNGASS) in 2000 and Beijing +10 in 2005. This article reviews progress reported on ICT-related Section J strategic initiatives and trends for ICT and gender between 1995 and 2005.

BACKGROUND

The gender equality objectives in Section J have been rooted in international agreements among United Nations member nations since 1947. The Universal Declaration of Human Rights (UDHR) recognized that "the inherent dignity and the equal and inalienable rights of all the human family is the foundation of freedom, justice and peace in the world" (UN, 1948, p. 1). UDHR Article 19 affirms the right to communicate and "to seek, receive and impart information and ideas through any media and regardless of frontiers" (UN, 1948, p. 1). These human rights, equally inalienable for women and men, are affirmed in the international treaty Convention on the Elimination of all forms of Discrimination Against Women (CEDAW; UN Commission on the Status of Women, 1979). Prior to the Beijing conference, CEDAW was referenced in the preamble preceding the 1989 UNESCO Convention on Technical and Vocational Education, which "provides for the right to equal access to technical education and pays special attention to the needs of disadvantaged groups" (Hamelink, 2005, p. 128).

The United Nations Commission on the Status of Women organized four world conferences on women. The first was in Mexico in 1975 at the beginning of the United Nations Decade for Women and focused on equality, development, and peace with the subthemes of employment, health, and education. The second was in Copenhagen in 1980. The third, in Nairobi in 1985, produced the Nairobi Forward-Looking Strategies for the Advancement of Women (1985), which affirmed that the:

realization of equal rights for women at all levels and in all areas of life will contribute to the achievement of a just and lasting peace, to social progress and to respect for human rights and fundamental freedoms. (United Nations, 1985, p. 1)

Beijing 1995

The Fourth World Conference on Women in Beijing in 1995 built on the Nairobi strategies and created the Beijing Platform for Action (1995). Just prior to Beijing, the United Nations Commission on Science Technology and Development Gender Working Group (UNCSTD-GWG, 1995) compiled research on gender, science, and technology interactions, particularly on applications that serve basic needs in the developing world. Most of the case studies focused on technical change that had differentially impacted the lives of women and men, and found men benefiting more from technical change. Further analysis identified male dominance in the decision-making chain as a prime reason for gender inequalities (UNCSTD-GWG). The Beijing Platform for Action helped situate gender equality as central in the global development-policy agenda by creating a gender-sensitive policy framework for achieving development goals through action targeted to human needs. Governments agreed to the Beijing Platform for Action and committed some resources to implement the objectives of its 12 target areas and to monitor progress at 5-year intervals.

Beijing + 5

The Beijing Platform for Action Section J had affirmed the importance of gender inclusion in ICT policy development at local, national, regional, and international levels. By 2000, policies to direct the ICT tools, so celebrated for their potential to effect change in developing nations, were only sparsely implemented toward programs for women's development. UNIFEM executive director Noleen Heyzer (2000) voiced concern that "globalization has failed to generate formal employment for women, but instead shifted their work to the informal and casual sectors." She stressed the "pressing need to assist countries to develop new frameworks that transform globalization to become pro-poor and pro-women, a globalization that is more socially accountable" and to utilize "the possibilities for connecting women and markets worldwide through the democratization of information and communication technologies and policies." She addressed the issue of the representation of women and called for greater gender equity in "expression and decision-making in and through the media and new technologies of communication."

Toward this objective, UNIFEM partnered with Cisco Systems to host the gender and ICT session at the Beijing +5 UNGASS. The session reported on women's leadership in ICT capacity building and information sharing for development. Discussion focused on best-practice action programs for the Section J objectives expanded to include ICT. New media ICT access and participation had moved toward gender equality in ICT-rich nations. In ICT-poor nations, data were less available. Many cases were reported of women's empowerment through ICTs for education, political voice and decision making, employment, and capacity development, but key obstacles of poverty and illiteracy kept most women in developing countries from ICT access and participation (United Nations, 2000).

The United Nations (2000) report on trends and statistics published for Beijing +5 identified the "need for new data on new media" (p. 100) and found new media boundaries are blurred between "genres and delivery systems" and "producers and users" (p. 100). Support for gender equality in hiring and gender sensitivity in programming was recommended in order to address escalating trends of gender stereotyping, pornography, and other degrading images of women and girls in media. The 2000 report also found "almost no data" (p. 100) on gender portrayal in new media, including Internet broadcasts, games, and newsgroups. The report recommended the development of complex measurement instruments to do this because "representations of women cannot be separated from construction of identity, use of language and new styles of interaction" (p. 100).

Beijing +10

Ten years after Beijing, the United Nations Research Institute for Social Development (UNRISD, 2005) analysis and report on progress focused more on the broad global challenges to women's well-being than on the specific progress of Section J, Women and Media, including ICT. The Beijing +10 UNRISD report found overall "uneven progress in an unequal world" (p. 5) in part because the state, a central instrument for human rights protection, must be "democratized to deliver gender justice" (p. 258).

UNRISD (2005) reported that "market fundamentalism has reduced the legitimacy of the state as the maker of national rules about the obligations and rights of citizens" (p. 258). The report acknowledged some gender-equality gains in primary education, political representation, and reproductive rights, and the fact that there are more women in the labor market. However, ILO data in the report showed increased jobs for women in ICT and other sectors, but most were in informal and low-wage labor, so there was little overall economic progress for women since Beijing +5. ICT and economic development progressed concurrently in China and India, but without concurrent development of gender equality in education, health, and economic distribution (UNRISD).

The Beijing platform and subsequent progress assessments in 2000 and 2005 also considered research evidence that policies, guidelines, and perhaps technologies are more gendered than gender neutral, strengthening the argument for gender-inclusive data collection and analysis:

> *Project-level data has well established that telecommunication and ICT are not gender-neutral. They impact men and women differentially, and in almost all cases, women have lesser access to and use of the media and lesser representation in the power and decision-making positions related to telecommunications and ICT ... special attention is needed. Without it, women will have fewer opportunities to benefit from the myriad possibilities of the information age.* (Hafkin, 2003, p. 1)

Nations and international organizations continue to monitor progress on the Beijing objectives, which remain a policy framework to guide the slow progress toward gender justice in ICT and other development areas.

FUTURE TRENDS

Beijing 1995, Beijing +5, and Beijing +10 have influenced the development of gender-focused research, analysis, and advocacy in ICT in the International Telecommunications Union (ITU), the UN ICT Task Force, and the 2003 to 2005 World Summit on the Information Society (WSIS). The ITU Task Force on Gender Issues (ITU-TFGI, 2001) developed "gender-aware guidelines for policy-making and regulatory agencies" intended to assist decision makers in their work to ensure that "both women and men are considered in the process" (p. 1). TFGI also found that

> *so-called gender-neutral policies or rules are not enough…women are vastly under-represented in government, business, political and social institutions; men still hold most of the management and control positions in telecommunication companies and regulatory or policy making bodies; regulatory decisions are often made without impact analysis; and service licenses are attributed to companies without equal opportunity policies and are controlled mostly by men. The following are a set of guidelines ... They can be used to ensure that gender-sensitive analysis becomes an integral part of licensing and regulatory activities. Successful implementation of these guidelines requires the development and promotion of such policies within the institutions seeking transformation into a gender-aware environment.* (p. 1)

The United Nations formed the UN ICT Task Force in 2001 to help mainstream ICT into development as a tool for digital opportunities and Millennium Development Goal (MDG) achievement. Gender inclusiveness and awareness have been evident in UN ICT Task Force policy and practice. Members are just under 20% women, and gender issues are regularly addressed in task-force work. The UN ICT Task Force has collaborated with the WSIS Gender Caucus and UNIFEM on the Kampala conference Bridging the Gender Digital Divide through Strategic Partnerships, which produced policy recommendations for gender and ICT including more research on ICT and gender issues.

Society of Women Engineers (2005) research using U.S. data showed that women in ICT education for electrical engineers, programmers, and software engineers progressed slowly from less than 10% of enrollment in the 1970s to 20% in 2000. Data showed similar ratios in these same ICT professions.

Graham and Smith (2005) found U.S. college-educated women represented only 24% of science and engineering (S&E) jobs. Women were underpaid, making 22% less than men. Though gender differentials in pay were even greater in non-S&E jobs, the authors recommended increasing S&E pay overall with policies to reduce gender earning discrimination in S&E jobs because gender inequalities negatively impact the growing information society's need for scientists and engineers.

Women are underrepresented and underpaid in S&E fields outside the United States as well. Data for world nations ranked by the United Nations Development Program (UNDP) Human Development Index (HDI) showed that women held less than half of professional and technical jobs in 26 of the top 50 nations. A comparison of earned-income data for all of the top 50 showed that women's pay ranged between 17% and 63% less than men (UNDP, 2004).

Research has established strong links between ICT growth and economic development, and between gender equality and human development, but ICT growth alone does not necessarily lead to gender equality or human development. King and Mason (2001) compiled substantial research that demonstrated the gendered nature of poverty and its effects, and therefore the need for gender-aware programs to combat poverty. Proactive policies for overcoming gender-equality obstacles in ICT access and growth are more common in ICT-resource-rich countries. Yet it is as important in ICT-resource-poor countries. A gender-sensitive ICT policy, even with scarce ICT resources, can direct ICT applications to the needs of women, their dependent children, and the poor.

A specific policy for gender equality in ICT development is needed if ICT is to contribute significantly to achieving an end to poverty as envisioned in the 2000 Millennium Declaration's eight MDGs.

Gender equality, one of the MDGs, is central to achieving the other goals. Women and their dependent children represent more than two thirds of the world's hungry, poor, and illiterate (UNDP, 2004). Understanding this, the UNDP developed the Gender Development Index (GDI) compiled from economic, education, and health indicators using gender-disaggregated data. The GDI is used to help assess progress toward the MDGs and the advancement of women in all areas of development. Gender-focused ICT education programs can prepare women for more skilled ICT jobs, improve local family incomes, and expand the national ICT skills base, addressing both poverty and gender inequality toward MDG achievement.

Gender research and analysis were part of the civil-society work prior to, during, and after the WSIS during the 3-year summit process. Plou (2005) described how gender relations in the ICT field sometimes reinforce old gender roles and power relationships, sometimes change them, but always require gender awareness in the developing information society. Plou says it is

> *not possible to think of new communication technologies as gender neutral. The absence of women's voices and perspectives in the information society also shows us that power relations in the new media replicate in many ways those in conventional media ... Women's access to information sources and communication channels are crucial if they are to attain democratic participation, respect for their human rights and an equal voice in the public sphere.* (p. 11)

Women are ICT users and content developers, particularly in new media, but are underrepresented among ICT policy makers. WSIS working groups for global policy development included Internet governance in their focus, which addressed technical standards, security, privacy, intellectual property issues, and financial mechanisms, and considered the Digital Solidarity Fund. Though women were well represented among the civil-society participants of WSIS, few women were represented among the thousands of government and business decision makers at WSIS (author's observation at Geneva WSIS; gender-disaggregated data not yet available). Even with much gender advocacy throughout WSIS, gender imbalance in policy making was still evident in the formation of the UN Working Group on Internet Governance (WGIG), which included only 4 women of 40 members (ITU, 2005).

The WSIS Gender Caucus and the NGO Gender Strategies Working Group negotiated strongly for gender to be included as a fundamental principle for action in the policy development process. Gender Caucus convener Gillian Marcelle (2003) said,

Women's perspectives can contribute to making the difference between an Information Economy where gambling and pornography account for the most profitable applcations and a true Information Society that serves human development ... making that leap will require radical transformation of the ICT sector so that all people, including girls and women of all ages, participate fully, not only as consumers but as citizens. This vision requires dramatic changes in the policies, practices and values of the ICT sector and the governance of the sector.

ICT and gender were critical issues debated and eventually included in the World Summit on the Information Society Declaration of Principles and Plan of Action. *The ITU World Telecommunications Report* (2003) focused specifically on how ICT applications could contribute to the achievement of gender equality, the empowerment of women, and the fulfillment of the other MDGs. Research and evidence show that continued attention to gender in monitoring the progress toward all the goals could help catalyze their achievement.

CONCLUSION

Gender-equality strategies, action plans, policy development, and monitoring processes were initiated through the UN decade for women, CEDAW, and the world conferences on women. The 1995 Beijing conference recognized and articulated how creating greater gender equality in ICT access, participation, and capacity building was important to the achievement of sustainable development with gender justice. Gender-equality conditions in the rapidly changing information society are interactive with progress toward ending poverty, hunger, illiteracy, preventable disease, violent conflicts, and social isolation. ICT also plays an essential role in creating informed political participants and decision makers. The Beijing process and the ongoing evaluation of Section J objectives continue to support proactive efforts through WSIS, the UN ICT Task Force, and the MDGs to create more gender-inclusive and gender-sensitive ICT policy-making bodies capable of enhancing gender justice in the information society.

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KEY TERMS

Beijing Platform for Action. Section J: Women and the Media: Strategic Objectives J.1., to increase the participation and access of women to expression and decision making in and through the media and new technologies of communication, and

J.2., to promote a balanced and nonstereotyped portrayal of women in the media (United Nations, 1995, pp. 134-136).

Millennium Development Goals: Eight goals agreed on by member states of the United Nations that address the effects of poverty and resource distribution inequities. The Millennium Declaration goals to be achieved by 2015 are the following.

1. Eradicate extreme poverty and hunger
2. Achieve universal primary education
3. Promote gender equality and the empowerment of women
4. Reduce child and maternal mortality
5. Improve maternal health care
6. Combat HIV and AIDS, malaria, and other major diseases
7. Ensure environmental sustainability
8. Develop global partnership for development

World Conferences on Women: International UN-sponsored conferences that addressed gender issues of human rights and equality important to local, regional, national, and international development and cooperation.

- **1975:** First World Conference on Women, Mexico
- **1980:** Second World Conference on Women, Copenhagen, Denmark
- **1985:** Third World Conference on Women, Nairobi, Kenya
- **1995:** Fourth World Conference on Women, Beijing, China
- **2000:** United Nations General Assembly Special Session on Beijing +5, New York
- **2005:** Beijing +10, New York

World Summit on the Information Society (WSIS): A two-phase international summit from 2003 to 2005 organized by the United Nations and the International Telecommunications Union to address the need for international policy and agreement on ICT governance, rights, and responsibilities. The WSIS Gender Caucus is a civil society representative of gender and IT issues.

Biographical Stories of European Women Working in ICT

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INTRODUCTION

There is a deep gender imbalance in information and communication technology (ICT) professions which are only about 17% female (compare Valenduc et al., 2004, p. 19) and, simultaneously, an unsatisfied demand for ICT professionals at intermediate and high levels. Although varying in different sectors and countries, a gender imbalance and a skills shortage are common features of the ICT labour market in Europe. This is an obstacle to the development of the knowledge economy and the achievement of social cohesion.

The project WWW-ICT[1] implements an integrated approach to the various aspects and dimensions of gender gaps in ICT professions, covering explicative factors linked to education and training, working and employment conditions, professional and technical culture. Most existing studies have limitations and gaps. They are often limited to classical computer professions, while WWW-ICT intends to encompass new professions linked to new communication technology, also taking into account the vocational training system. Studies of the shortage of ICT professionals are mostly centred on the demand/supply relation, while we focus more on the role of professional models and professional trajectories as a factor of integration or exclusion.

In general terms, employment in the ICT sector has been growing very markedly across the EU in recent years. The sector is increasingly dominated by specialist firms, which have taken over the provision of computing services for client companies. Computer services in the EU are dominated by SMEs; the majority of computer services businesses are micro-businesses employing less than ten employees (Björnsson, 2001). Despite the predominance of micro-businesses, there is a huge concentration of employment in bigger companies. This is the context within which women are employed in ICT.

BACKGROUND

Under-representation of girls and women in computing is a reality and "the reasons why women are not attracted to engineering in great numbers are subtle and complex defying monocausal explanations and solutions" (Adam, 2001, p. 40).

Much of the current discourse around the gender gap in computing is grounded in the debate on women in science and technology that dates back to the early 1980s. This debate revolved around some of the fundamental theoretical difficulties of addressing gender issues. One of these difficulties is to do with a dualistic notion of the world. Criticism of a dualistic construct of gender led to an increasing interest in "difference" (rather than sameness) on the one hand.

On the other hand the first studies of practising women scientists suggested that women choose science for similar reasons as their male colleagues: for the adventure of abstract thought, for the intellectual pleasure that analysing a problem, looking for details, isolating and manipulating variables provide (e.g., Carter & Kirkup, 1990). It was argued that people with the bodies of women do not necessarily have the minds of women. Evelyn Fox Keller (1987) was among the first feminist scholars who used gender not as an empirical category but as an analytical tool to elaborate and concretise the idea of difference and dissent within the sciences. Feminists introduced notions such as polyvalence, epistemological pluralism, and partial translations into the discourse on gender and technology (Wagner, 1994).

Much of this older debate has been absorbed by Judith Butler's notion of gender as "performed" (Butler 1993). It has been taken up by many feminist scholars and, interestingly, extended to technology. Jennifer Croissant argues: "We gender a technology by painting it blue and handing it to a boy. We gender the boy in this interaction, providing a frame of reference for appropriate technological and masculine identity associations and expectations. We of course provide a frame of reference for the girl to whom we do not hand it. We perform with technologies. The technology, with its scripts, schemes, and codes, also performs us in that we become subject to its affordances designed or there by happenstance when we start the performance" (Croissant, 1999, p. 278).

This argumentation leads to a second difficulty of theorising about technology and gender. Assumptions about the technologies that are examined in studies of gender differences are often quite general and superficial. In an early essay on women and technology Knapp (1989) argued that women's ways of doing and thinking are not independent of the object world. Her main criticism of studies of women's relations to the natural and technological world was that these almost exclusively look at the subject—women—disregarding the interactive nature of appropriating a technology. Not only are computers different from other technologies in ways that may affect the ways women and men interact with them. The range of computing applications dramatically expanded during the last decade and with it the range of computing professions. Looking at gender as performance and performed and at computers as highly specialised and varied technologies, has consequences for the method of 'measuring' gender differences. Kay (1992) has argued, "that to fully understand whether gender differences exist in human-computer interaction, a qualitative, contextual, developmental approach should be employed to examine specific tasks. He stresses that without this comprehensive understanding, researchers will continue to identify only pieces of a very complex puzzle" (quoted in Mitra et al., 2001, p. 228). A good example of such a contextual approach is Linda Stepulevage's (1999) reconstructing her own making into a technology expert using the method of autobiographical narrative. She emphasises the actual everyday practices that surround technologies—"people making and doing things." Understanding this "making and doing" is tied to particular locations and contexts (Stepulevage 1999).

It has been argued that in IT as a relatively young field women would not face the same barriers for working careers existing in other fields with a traditional male dominance. Ahuja (2002) argues that this viewpoint does not "adequately take into account the variety of structural and social factors that inescapably and inevitably shape women's careers in IT throughout industry and academia" (p. 22). Noticing a lack of academic studies on gender differences in IT careers she claims that it is important to understand the role of women in the field of IT and "how or if IT differs from other professional endeavours in offering opportunities to women" (p. 21). With that aim she proposes a conceptual framework that covers social factors as well as structural ones influencing women's professional careers in IT.

METHOD

Our qualitative research is based on biographical interviews. The analysis attempts at preserving the biographical aspect of informants' narratives while at the same time looking at more general patterns across individual biographies.

The aim of a biographical interview is to develop an understanding of a person's biography or trajectory—her development as based on opportunities, choices, and individual coping strategies. Crucial concepts are developmental tasks in particular phases of one's life, individual coping strategies in relation to given structures, detours and their implication for the person's biography, transitions (changes of field of work, occupation, life situation, etc.) and life themes (Thomae, 1996) (i.e., topics that emerge in the women's own accounts as crucial for understanding their choices).

The focus of our interviews was on the women's work biographies, with an understanding that these

Table 1. Characteristics of interview partners

Age	from 22 to 55, highest proportion between 31 and 40 years
Qualification	from no ICT related initial training to university degrees in ICT and other subjects
Job Profiles	project management, developing, leading position, Web design, support, marketing, teaching
Firms	large/small companies (more/less than 100 employees)
Status	salaried, self-employed, full-time, part-time
Residence	city/countryside, different regions within the countries

are inseparable from their identity and concept of a good life. Silvia Gherardi's narratives of "women travellers in a male world" come closest to this notion of biographical interviews (Gherardi, 1996). Our interviews are what Flick (1995) calls episodic interviews with a strong narrative character. The main idea is to stimulate a person to tell "stories"—significant episodes in her life that illustrate the whys and hows of important events in her biography. We interviewed 107 women (15 or 16 in each of the seven countries) who were selected according to a set of criteria (see Table 1).

LIFE STORY PATTERNS

The categories we use in our analysis of biographical (life story) patterns are not theory-based but empirical, grounded in the material itself. They reflect some of the colour the women themselves gave to their narratives. We discovered eight main patterns. Each pattern has its own characteristics and its influence on the informants' career paths in ICT.

For this article we have selected four patterns that we found among the women interviewed. These patterns represent different paths into or in ICT professions. All the women belonging to the selected examples manage their working life rather successfully and are on the whole satisfied with their jobs. This selection is due to our focus, namely to emphasise successful careers, in order to find a new quality of research and recommendations. As a lot of existing studies focus on deficiencies, we try to find out positive role models of women, who found a way to manage their professional lives in the ICT sector. To our opinion women's careers are rather defined by their contents, their work practices, interests, opportunities and motivations behind than by obstacles and barriers. Positive examples in this sense give us the possibility of formulating recommendations for "agents of change" more precisely and realistically.

Straight Careers in ICT

Straight careers in ICT can be found in all the different national cultures. They are moved by strong interest in math and sciences and in some cases, looking for a field with good job prospects. This is reflected already in the first educational choices the women take: They follow a technical education from the start, studying computer science or maths or engineering. One of the women says that what she likes about her work is "solving riddles and generally the curiosity to get to the bottom of things."

These women follow one of the predefined trajectories in ICT. They pursue a university career or very consequently climb up the career ladder in the ICT industry. They are extremely hard working. They may have a broad range of interest in their private lives but in their work they are very focused, taking extreme pleasure in mastering the intellectual challenges of their discipline. They have high ambitions and strive to the top. The conditions for being successful—a hierarchical structure, a competitive environment, and long working hours—are accepted. One woman describes that work had become very much a life style. The definition of her identity included late working hours and socialisation over a drink.

Combining Art with Technology

In these careers, it is not technology that is in the foreground but a passion for art or journalism, with ICT entering later as an important tool and skill.

These women work in publishing or advertising. Typical of all these careers is the ease with which the women integrated ICT into their work, developing a passion for both fields, but with their artistic interests and ambitions staying in the foreground. Regarding their life style and way of working they are more artists than computer professionals.

Typically for these careers that are close to the arts is that there are no boundaries between professional work, social commitment and private life.

From the Margins to a Field of Opportunities

There are life stories in which ICT is strongly connected with moving out from one's milieu or region into promising and relatively secure jobs. While in several cases informants come from marginal regions—the countryside in the case of Austria, the South (Sicily) in the case of Italy—in a few other cases it is ethnicity which creates a potentially marginal position from which the women escape. In some cases the women rebel against their home environment. For example for one British woman of Indian ethnic origin the expectations of her parents that she would simply marry and have children in fact gave her a strong motivation to pursue her education and get a good job. However, in most cases the women stay emotionally attached to their original family offering them different kinds of support.

These women are interested in working with technology but not passionate. ICT opens a field of opportunities to these women. Entries into ICT vary. While some of the women studied informatics or something related, others encountered ICT in their first (clerical) jobs, seizing the opportunity to qualify themselves, either through learning by doing (the older ones) or through additional training. One of the prime movers of these careers is the chance to get a well paying job offering security, possibly in a large company.

Building One's Own Environment

Some informants' stories show a strong will and skill to shape their own environment so that it fits their idea of good work and a good life. This is a theme in their accounts which they address explicitly as "building". These women are very self-confident. They have clear goals and set the steps to achieve their ideas and ambitions. Their strong motivation takes them into different directions. It includes going abroad as a single woman to be exposed to other cultures, being in charge of their own life from a quite young age on, founding their own company, carving out their own field of expertise, building things on their own, fighting for a good position.

Some but not all of them come from supporting families. Their parents and often especially the mothers encouraged them to go their own way and get independent. Many of these women also chose supporting partners with whom they share child caring responsibilities and who support their careers. However, there are also women who have to manage job, household and family on their own with no encouragement or help from other family members.

These women define themselves through the content of their work. This may also include broader interests, such as political commitments or artistic interests. Some of the women work as mentors and encourage other women in ICT.

CONCLUSION

Among our interviewees we found a great variety of jobs, entry routes, education as well as motivations and interests in working in the ICT sector. With the life story patterns we tried to capture this diversity without disassembling it into single "influential factors." For the women in our pattern of "Straight careers in ICT" the focus of their motivation is clear on technology. They like the challenges of their work and they are very ambitious. Contrary is the motivation of women who come "From the margins to a field of opportunities." For them ICT offers the chance to get out of their milieu. They usually have a quite "natural" relationship to technology, seeing it as a means to fulfil their tasks, but they are not passionate about it. Women who are "Building one's own environment" are very successful in realising their goals. They actively use the openness of the ICT sector that often lacks predefined job profiles to create their own working environment. The ICT sector is also open in another sense. This can be seen from the experience of women who are "Combining art with technology." These women come from other educational backgrounds and find ICT as an important tool for their work in art, graphic design, or journalism.

Our results from the interviews and case studies show that ICT professions are more varied than often assumed. By using a qualitative approach we were able to understand the motivation of women working in ICT professions from their own viewpoint in the context of their life stories. The result is a lively picture of the situation of women in the ICT sector that sheds light on the women's motivations and needs as well as on the working conditions in the ICT sector. These insights can be used to formulate recommendations[2] that are based on women's experiences from their work practices in ICT professions and that go far beyond the elimination of constraints.

FUTURE TRENDS

The ICT sector is a rather dynamic field. The permanent changes of the sector are tightly connected to the development and the growing of new jobs and new professional areas. Due to the rapid technical improvement it is a challenge to imagine future scenarios. As the ICT sector is a rich area of opportunities for men and women with different educational and qualification backgrounds we notice the necessity of continual research to analyse what is changing. It would be very helpful to improve and update the existing job descriptions and opportunities and to connect research institutions, labour market experts, and counsellors. We observe a great lack of comparable quantitative data as well as a sufficient number of qualitative studies, among them our study is just one contribution to a deeper understanding of the ICT sector. Quantitative and qualitative research should lead to better information about the chances and career options women may have in the ICT sector and so work against the under-representation of girls and women in this area.

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KEY TERMS

Agents of Change: Experts and institutions connected to the labour market, the educational and vocational area, industry and politics who should work against the gender imbalance in ICT following the recommendations of research projects. Agents of change are e.g. vocational advisors, counsellors, human resources managers, trade unionists, European and national institutions, social partners, public institutions, teachers, parents and students.

Biographical Interviews: Qualitative interviews, partly pre-structured with a strong narrative character; stimulates a person to tell "stories"—significant episodes of his/her life. Normally the interviewee covers several topics in his/her narration in his/her sequence.

Gender Imbalance in ICT Professions: Various aspects and dimensions of gender gaps in ICT professions, covering explicative factors linked to education and training, working and employment conditions, professional and technical culture.

ICT: Information and communication technologies.

ICT Professions: Rely on professional ICT skills in the ICT industry and in the user industries and services; characterised by the predominance of ICT knowledge; cover a range of tasks including conceptualisation, design, development, implementation, upgrading, maintenance or management of ICT systems and tools.

Life Story Patterns: Typologies drawn from biographical data of the interviews; clusters covering several criteria including career paths, background, education, etc. as well as individual life styles, coping strategies, cultural aspects, etc.; categories of the analysis are not theory-based but empirical, grounded in the material itself. They reflect some of the colour the interviewees gave to their narratives.

Life Themes: Topics that emerge in the person's own accounts as crucial for understanding their choices both in working and private life; can be drawn from biographical interviews. One person may have several different life themes.

ENDNOTES

1. This article is based on WWW-ICT/Widening Women's Work in Information and Communication Technology, a project carried out under the 5th framework programme of RTD of the EU in 2002-2004. http://www.ftu-namur.org/www-ict.
2. Conclusions and recommendations can be found in our report (Valenduc et al., 2004).

Boards Need Women with IT

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INTRODUCTION

In comparison to research on gender diversity on boards, little research has been conducted on the diversity of board skills required for survival in our fast dynamic world, where boards are becoming more responsible for IT strategy, and where skills to optimize technology strategy and execution for maximum business value are in demand.

In this article, the importance of IT knowledge to overall board governance and the value of women with IT skills as board members are explored. A gender profile is developed from the Australian Stock Exchange (ASX), the Equal Opportunity for Women Agency (EOWA) and the Women on Boards 2004 reports. A discussion on relative contributions to board performance is undertaken.

Under the banner of diversity, research into board composition historically has focused on gender issues—where more specifically the lack of women appointed at board levels has been discussed. There is a significant volume of research that verifies the lack of female representation on boards. One example from the EOWA 2004 Census shows that for the top 200 companies listed on the ASX on June 30, 2004, the number of women executive managers in Australia's companies has increased since 2003 by 1.8% to 10.2%, while the number of women board directors has increased since 2003 by only 0.2% to 8.6%. Additionally, 42.0% of companies have no women executive managers and 62.1% of women (but only 31.4% of men) occupy support positions—as opposed to the line positions that ultimately lead to CEO or Board appointments.

This article draws links between IT skills, governance, and women with IT skills at the board level.

BACKGROUND

A view is emerging that the number of technology failures are increasing and that corporate boards in Australia are failing to meet expectations in this area. Various studies show that IT promises are rarely fulfilled, with failure rates as high as 97% being quoted for some projects (da Cruz, 2003).

With this volume of failures resulting in poor organizational performance, combined with increasing attention on corporate governance and a growing realization that IT portfolios are complex, one would expect more enterprises to implement frameworks for IT governance to more tightly focus their IT processes, people, and priorities on achieving business goals. As Broadbent (2004) says, "Lack of director experience in IT, or just plain ignorance, is an increasing problem in the technology age. The business significance of IT capabilities and assets is now very high." Yet Broadbent further explains that very few of the top 100 Australian boards have even one board member with top-level expertise in integrating IT into business processes or envisioning how IT might be changing their industry.

This is reflected by Turnidge's (2002) findings: "In Australia, board skills continue to reflect legal, financial, and engineering backgrounds, often with relatively limited international experience or skills related to the knowledge economy (such as science or technology)." Similarly, research firm Burson-Marsteller (2004) reported that just 5% of the global Fortune 500 companies have a CIO or former CIO on their board.

The call to include technology skills on boards is further supported by Huff, Maher, and Munro (2004) who point out that boards are disinclined to discuss IT and do not comprehend the associated risk. Huff et al. (2004) conclude that:

... emerging technologies and changes in the business environment are redefining the role of

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corporate boards with respect to IT governance. By asking the right questions, bringing senior IT management into board discussions and recruiting IT talent at the board level, boards can become much more effective in dealing with IT issues.

Increasingly, researchers are making the links between good governance, diversity, and corporate performance. For example, Brown (2003) points to a study that quantifies what many investors intuitively have guessed, that companies with weak governance trail the market.

The call for diversity on boards has been widely discussed. The best boards know how to have a good fight. Diversity in experiences, skills, viewpoints, perspectives, talents, and ideas is a positive (Sonnenfeld, 2002). Diversity is about enriching the leadership platform with different perspectives by having a team of people with different frames of reference." This is further supported by Allen (2003), who states, "companies that will succeed in the 21st century are the ones that will learn and adopt fastest…and that embrace diversity of thought, style, and culture."

WHY IT SKILLS?

Case Study ID550 by Ovum (2003, p. 7) advised that investment in IT:

... requires consistent firm strategies, effective internal and external communication, and a careful assessment of risk. Implementation is often complex, with organizations seeking to balance the needs of multiple stakeholders while ensuring a satisfactory ROI.

Turnidge (2002) supports this view by warning that deciding what is good governance in the technology age is becoming increasingly difficult. With IT having such a direct and immediate effect, boards are as accountable for IT and the associated strategic risks as they are for finances and legal compliance issues. IT governance cannot be designed in isolation from the other key assets of the firm (such as financial and human) and ultimately requires representation at board level.

The argument to include IT skills on boards is strongly supported by Burson-Marsteller's (2004) research, which found that boardrooms need to open their doors to directors with technology skills and competencies in order to unleash innovation and economic growth. Leading companies who had transformed the business landscape by including technology experts on their boards delivered annual returns 6.4% above their industry average.

Broadbent (2004) flags another key driver as being risk management: "IT assets are now just one asset class among others that companies deal with... But increasingly, if not managed appropriately and well integrated into the business they leave organizations exposed to huge risk and competitive disadvantage." Broadbent further warns that boards do not always have expertise in "envisioning how better IT-enabled business can improve positioning." This skill and risk profile is reflected by a statement made to Broadbent at a 2004 presentation: "I don't want to see my company in the headlines for the wrong reasons. We suspect we are at risk but we are not sure exactly how to assess that." The author suggests that IT expertise at board level might address this.

The issue can be brought down to risk, as Siwik and Randall (2004) indicate:

The emerging standards of corporate governance are forcing businesses to abandon their traditional silo-based risk management approach. As we have seen with Enron, silo-based risk management permits business leaders to point the finger elsewhere with nobody ultimately accepting responsibility … Every company, regardless of size, should work to measure, manage and monitor risk in a coordinated manner. Businesses are a complicated blend of knowledge, technology, people, processes, and capital, and the only proper and effective perspective is a comprehensive and strategic one.

Thus, we can draw the conclusion that if board governance is to be effective within our changing environment where strategic issues include the significant financial and operational issues associated with IT investment, then board members must demonstrate an ability to understand the implications of IT decisions. IT expertise belongs on the boards of companies alongside traditional financial, legal, and general management skills.

WHY WOMEN?

There is no question of whether women are qualified: to be board members, CEO's, scientists or other professional roles. That was decisively answered years ago: some are and some are not, just as some men are qualified and some are not.

Research indicates one compelling reason to appoint women as board members: improved performance/outcomes. Despite this, Australia lags behind the USA and Canada, where 86% of US Fortune 500 companies and 62.4% of the Canadian Financial Post 500 have at least one woman in an executive management position.

This lag is demonstrated by the EOWA 2004 Census. It shows that women, although 43% of the total Australian workforce, currently account for only 3.2% of top executives, with only 5% in the line-officer pipeline. In addition, according to the ASX in 2003, women held only 8.4% of board directorships in the top 200 ASX companies, and 47.3% of Australian companies had no female directors. Therefore, there is still a long way to go within Australia towards recognizing the value of appointing women at board level and the resulting improved performance.

The question to ask is, does selecting on gender necessarily result in improvement in the business areas that count? This question was addressed by Adler (2001, pp. 4-5), who tracked 215 Fortune 500 companies, comparing their financial performance to industry medians. He found that "companies that smash the glass ceiling also enjoy higher profits." Furthermore, "the companies with the highest percentages of female executives delivered earnings far in excess of the median for other large firms in their industries."

Brown, Brown, and Anastasopoulos (2002) findings support those of Adler. It tracked the financial well being of Canadian firms with two or more women on their boards in 1995 to see where they stood six years later. It found that firms with women board members were much more likely than companies with all-male boards to be leaders when ranked by revenue or profit.

These findings are reflected in Australia in the 2004 EOWA census and the 2004 Women on Boards research, which indicated a significant trend of better financial results for companies with female directors.

Other studies show that boards with more women use more non-financial performance measures such as more regularly reviewing customer satisfaction, employee satisfaction, gender representation in management, improved community relations, innovation, and connection to a wider customer base. This shows that appointment of female board members broadens the focus of issues that boards consider. While these studies do not make a theory, they do strongly suggest a positive relationship between the presence of women on boards, good corporate governance and financial performance.

Simply put, board diversity, specifically an increase in the number of women board members, is good business. It strengthens governance, promotes marketplace competitiveness, builds employee morale, and is a source of positive Public Relations for shareholders and the public. In addition, improved performance in those areas adds up to improved financial performance (Women on Boards, 2003).

WHY WOMEN WITH IT SKILLS?

Sonnenfeld (2002, p. 9) implies some interesting questions: "How well can board members with mostly similar experiences and backgrounds ensure that the full range of strategic risks facing their organization have been identified?" and "How can board members with similar perspectives and frames of reference truly assign a value to risk management and oversight?"

The question of assessing risk begins to be addressed by Brown, Brown, and Anastasopoulos (2002) who found that more female than male directors pay attention to audit and risk oversight and control; that women, more than men, tend to consider the needs of more categories of stakeholders; and that women, more than men, tend to examine a wider range of management and organizational performance. In addition, the research found that 94% of boards with three or more women (but only 58% of all-male boards) insist on conflict-of-interest guidelines.

With respect to IT knowledge, the challenge is to locate board representatives that are able to ask the right questions to unravel the "secrets" of IT in such a way that other board members can appreciate the associated risk and business imperatives without the need for technical detail, acronyms, and other jargon. Craig (2004) flags that "the research literature shows that there are many people in Australia who have established that they believe passionately about the need for diversity ... They consider that women can bring a different perspective and alternative skills that will help create better systems for all." This is further supported by Jamnik (2004), who advised that in the knowledge economy better decisions would be made by including women in the decision process.

Thus, the preceding discussion implies that if women with IT skills were appointed at board level then:

- More attention would be paid to associated IT risks
- Implications of IT activity would be considered enterprise wide, encompassing a wider field of stakeholders
- Better decisions would be made
- IT strategy would be linked to business objectives
- Board performance would be improved
- Company financial performance would be improved

ISSUES

Where are the Women?

Anecdotal evidence in Australia is that those seeking board members advise, "they would have appointed a women but could not find one," which raises the question of "Where are the Women?"

Key issues that need to be considered when seeking suitable women for board appointment are:

1. Women are not visible at executive levels
2. An increasing number of women are departing corporate firms to establish their own businesses
3. The majority of firms (up to 97%) within the Australian IT industry are small (less than 20 staff) not publicly listed firms (ABS, 2002). This trend appears evident globally.

Traditionally, board recruiting in Australia has tended to be fairly informal, conducted largely through existing directors' networks. Historically this has appeared to work, but it naturally limits the pool of potential candidates. The author suggests that despite frequent claims to the contrary, there are talented individuals who qualify as potential board nominees. The problem lies in the fact that they may not be well known within directors' networks because they are not ex-CEOs or Directors of public companies.

This implies changes are needed to recruitment practices of boards for those seeking to appoint women to boards and more specifically women with IT skills. Such changes would incorporate actively seeking women who may not be visible in the top 500 firms, but who possess the required skills and abilities but have opted out for smaller organizations or set up their own businesses (Allen, 2003).

More specifically, boards seeking women with IT skills ought to adopt a strategy of aligning with industry associations that are attracting women with business and IT skills. Interestingly, the past two years has seen an increase within Australia of projects and programs targeted at attracting, registering, and skilling up board ready women (AWISE, 2005; WIT; Women on Boards, 2003). Therefore, the pool of potential candidates is increasing, and the issue is looking in the right places.

Women and Profits

More research is needed on cause and effect re the better financial performance associated with appointment of women on boards: particularly in gauging if it is due to the impact of women on boards, or if successful firms tend to be less conservative and more innovative, and more likely to appoint women.

Gender vs. Individual

While a link between greater board diversity and company performance has been established, research is required to determine how much of this is due to more balance in gender etc. vs. better selection of individuals with the right skills outside of the reigning social group or network.

FUTURE TRENDS

Fundamentally, this article is proposing three future trends:

1. Board governance to incorporate IT strategy
2. Appointment of people with technology skills, and more specifically women with IT skills, onto boards
3. Modifications to the board appointment recruitment process to increase the visibility of women who are not current or ex CEOs

This is about improving company performance, where a genuinely representative board brings together individuals with different experiences, skills, and points of view. This suggests the need for careful consideration in the future of the board composition, to better meet not only business needs of the company, but with more emphasis on the skills required for understanding technology impacts and directions.

CONCLUSION

The focus of a significant volume of literature about diversity on boards has been on gender issues. This article broadens the gender debate to include skills and learning/communication styles, more specifically the inclusion of IT skills on boards. In our dynamic world where boards are becoming more responsible for IT strategy and investment, gender balance is only one aspect of this larger issue.

This is summarized by Slater (2003):

The board in the business environment in this century might be characterized as smaller, leaner, and more diversified, with technology comprehension, business acumen and an energetic entrepreneurial drive.

It is not rocket science. We draw the conclusion that to enhance the ability to succeed in the 21st century, IT skills belong on the boards of companies alongside traditional financial, legal, and general management skills.

The facts are:

1. There is strong evidence that indicates that diversity (specifically appointment of women) enhances board performance
2. We are in a fast paced society where technology is an underlying infrastructure across many businesses and boards need to pay attention to IT governance
3. There is already an "invisible" pool of talented women with IT skills suitable for appointment to boards: recruitment strategies just need to source these women to amplify the impacts and enhance board diversity and performance

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KEY TERMS

Board/Board of Directors: Includes commercial, government, and not for profit boards, and board members refers to executive and non-executive as well as voluntary and ex officio appointments.

Board Composition: The mix of specific skills in areas such as marketing, finance, law, risk management, industrial relations, asset management, communications or public relations, economics, IT, change management, and broad strategic awareness.

Corporate Governance: Promoting corporate fairness, transparency, and accountability. Governance is essentially about ensuring that business is conducted properly. It is less about overt control and strict adherence to rules, and more about guidance and effective and equitable usage of resources to ensure sustainability of an organization's strategic objectives.

Diversity: Refers to more than just representation of diversity of skills and experience in the composition of the board. The board, in its directorship base, should also possess a diversity of styles and views. Diversity refers to differences across a range of demographic attributes including gender, age, religion, ethnicity, national origin, physical and mental ability, level of education, marital and family status, and sexual orientation.

IT Governance: Provides the framework and structure that links IT resources and information to enterprise goals and strategies. As defined by Broadbent (2002) IT governance specifies the decision rights and accountability framework to encourage desirable behavior in the use of IT. It is not about IT management and the detail of particular IT decisions and their implementation, rather about the arrangements for who makes critical decisions and who is accountable for them.

IT/Information Technology: A term that encompasses all forms of technology used to create, store, exchange, and use information in its various forms. Reference to IT/Information Technology is deemed to include the "C" of "ICT" information and Communications technology, which is the technology used to handle information and aid communication.

Knowledge Economy: The Department for Trade and Industry's (1998) flagship policy document *Our Competitive Future: Building the Knowledge-Driven Economy* states that:

[a knowledge based economy] is one in which the genderation and exploitation of knowledge has come to play the predominant part in the creation of wealth. It is not simply about pushing back the frontiers of knowledge; it is also about the more effective use and exploitation of all types of knowledge in all manner of activity.

ROI: Return on investment.

Bridging the Entrepreneurial and Technology Gap for Women

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INTRODUCTION

In the early 21st century, there continues to be an unbalanced ratio of males to females both studying for and in technological positions in Ireland. For example, computer science is a relatively new discipline. It was hoped that in such disciplines women could establish themselves and would "break new ground in professional access and equity for women" (Pearl, 1995, p. 26). This has not been the case. It is generally accepted that about 20% or less of places in engineering and technology (E&T) courses in Irish third-level colleges are filled by women (Richardson, O'Brien, & Moore, 2002).

Furthermore, as a result of low levels of female participation in E&T jobs, there are corresponding low levels of female participation in technical self-employment. Women in Ireland are 2.6 times less likely to start a business than their male colleagues; females in Ireland are more averse to risk taking and are cautious (Fitzsimons, O'Gorman, & Roche, 2003). This can be attributed to gender-generic factors (Hynes, 1996). These factors include personal profiles, situational and personality characteristics, and self-belief that manifest as barriers to female participation in enterprising activity (GEM, 2004). To overcome this scarcity of technological knowledgeable females in self-employment, it is necessary to determine the source of this problem. This is achieved by interlinking research in these two topics, which are generally researched independently, but when researched together, they add value to and inform the debate in the Irish context. The research involves the identification of the sources of these barriers with a view of devising corrective interventions. It is suggested that the role of education is instrumental in overcoming these barriers. Consequently, in this article, we propose a framework that can be modified to suit the needs of female students.

BACKGROUND

In the Irish context, the number of females entering technology professions is still very low. In a recent report from the European Commission (2003), it is stated that "men graduates are consistently more likely than women graduates to be graduating from Engineering programmes, and, with the only exceptions of Belgium and Spain, from Science, Mathematics and Computing programmes" (p. 45).

Current Status of Female Participation in Engineering and Technical Education

In the second-level school system in Ireland, there has been an improvement in the uptake of science subjects among women. In 2000, 47% of those taking leaving-certificate higher level mathematics, 30% of those taking higher level physics, 56% of those taking higher level chemistry, and 71% of those taking higher level biology were women (Forfás, 2003a). The numbers of women in other subjects that are the basis for further study in E&T are much lower: applied mathematics (21%), engineering (4%), technical drawing (8%), and construction studies (5%). Computer science or information technology is not offered at the leaving-certificate level in Ireland. Furthermore, the number of females entering E&T courses in the third level remains low. In

2002, in engineering or technology courses, one female accepted a place for every four males (McDonagh & Patterson, 2002).

At the postgraduate level, this downward trend continues. According to Forfás (2003b), only 17.1% of PhD researchers and 20.9% of non-PhD researchers are female. Within the engineering, manufacturing, and construction category, 22.2% of postgraduates were women (European Commission, 2003). On the positive side, while women constitute 39.6% of higher level graduates overall within Europe, their numbers are increasing by an annual average of 4.8% as opposed to 0.9% for men. The growth difference in Ireland is not as great with 6.9% growth for women and 6.0% growth for men (European Commission).

Implications for Business and Society

Although women's influence on project teams can cause significant changes in the design of products, their numbers are too small (even at 20%) to have a continuous significant effect. The construction of infrastructure, both physical and technological, is being carried out mainly by men, yet women make up over 50% of the population (Central Statistics Office [CSO], http://www.cso.ie). The late Anita Borg from Xerox has been quoted as saying, "If women were more involved in creating new technologies, cars would have a place for you to put your handbag" (Smith, 2002, p. 1). Florida (2002, p. 249) argues that "diversity and concentration work together to speed the flow of knowledge." Or, as Trauth (2002, p. 102) states, "women in the IT profession, as a group, are different from men, as a group, in the profession, albeit for sociological rather than biological or psychological reasons." Ultimately, the diversity offered by female influence during technological design is often missing.

Technology-based policies influencing society are being made without women's input. Issues such as privacy and security, the misuse of the Internet, and the location of telecommunications infrastructures are significant. Women currently in the engineering and technology workforce can exert some influence, but women's influence must become more far reaching. Indeed, in Ireland, although there is a government target to have state boards composed of at least 40% women, the figure is closer to 25% (NDP Gender Equality Unit, 2000)

For individual women who are turning their backs on technological careers, the effects are very significant. As the statistics show, the lack of mathematics skills is not a recognised hindrance. Individuals are missing out on rewarding positions offering a variety of tasks that include working with people. These jobs are often highly paid (CSO), with new learning opportunities always possible. Contrary to common belief, it is unusual for careers in this area to be "geeky," antisocial, and boring. The absence of women participating in these disciplines results in lost career opportunities for women, and on a broader scale, results in lost opportunities for industry and the general economy of Ireland.

This loss is further encountered within entrepreneurship. The potential for women to become entrepreneurs in engineering and technology, the high-tech industry, is lost. Women who are capable of pursuing technological careers in established firms fail to transfer this knowledge to the establishment of their own businesses, unlike many of their male counterparts.

Current Status of Female Participation in Entrepreneurship and Small-Business Ownership in Ireland

Statistics suggest that the level of entrepreneurial participation by Irish females at 3.7% is lower than in the United Kingdom or United States (Fitzsimons et al., 2003). In Ireland, women make up only 15% of Irish entrepreneurs, and entrepreneurial participation by women halved between 2001 and 2003 while that of males declined by 26%. This report also found that more educated women are more likely to engage in entrepreneurial activity. While the intention to start a business is high among females in relation to males, the follow up and transition to actually starting a business is much less for females (Fitzsimons et al., 2003).

This compares to an average of 29% of females in Europe who are engaged in enterprising activity (Observatory of European SMEs, 2003). In 2003, Ireland ranked 6th among the 22 OCED countries in terms of women who were thinking of starting a business. However, this ranking slips to 17th place when comparing the percentage of women who had actually started a new business (GEM, 2004). Why is this the case? And more importantly, what can be done to remedy this situation?

Research studies in Ireland (Goodbody Economic Consultants, 2002; Henry & Johnson, 2003; Limerick City Enterprise Board, 2003) have attempted to identify why this low participation exists and what the perceived barriers are that females encounter in managing their own businesses. Goodbody Economic Consultants found a number of common factors including social conditioning and expectations of females in society; the perceptions of the demands of running a business; glass ceilings; a lack of female role models; the low proportion of women pursuing science, engineering, and technology programmes; a lack of self-confidence and self-belief; and difficulties in reconciling work and family life for females as all contributing to low participation.

Henry and Johnson (2003) found that the main barriers and challenges to self-employment were associated with funding, the entrepreneur not being taken seriously, and time management. The time-management issue centred on the need to balance business activities around family demands and circumstances. These findings are also reflected in research completed by the Limerick City Enterprise Board (2003). It found that female entrepreneurs indicated that their business choice was related to their interests, hobbies, and values. Factors such as previous work experience did not rate highly as influencing their choice or type of business venture.

This research found that females tended to be less confident and assertive in the initial researching and selling of their business idea and in the acquisition of resources. Respondents did not have previous management positions prior to start-up, which they felt was a disadvantage. However, it can also be argued that many males entering self-employment do not have management experience or skills either; however, it is not an issue that is perceived as a barrier by them in the development of their business. This relates to the broader debate on the role of females in the workplace and in management positions, and how in many instances current management roles, practices, and values are still male dominated. The female entrepreneurs considered that they could benefit from enhanced management skills and confidence in the ability to network and sell not just the idea, but themselves in a confident manner.

Research would also suggest that these issues influence the type and profile of new businesses established, with very few new businesses established by females in the technology and engineering fields. Research by Goodbody Economic Consultants (2002) and the NDP Gender Equality Unit (2000) suggest from their respective research that females tend to start businesses in the general-services, tourism, and financial-services sectors, while men tend to start more businesses in manufacturing, construction, and technology areas. A range of personal profiles, personality characteristics, and educational and industrial work experience greatly influences the attitudes, perceptions, knowledge, and exposure to self-employment and the choice of career options for females (GEM 2004). Once identified, the challenge for policy makers and educationists is to determine how these obstacles can be best addressed and overcome.

FUTURE TRENDS

We suggest that targeted education programmes that incorporate and integrate both technology and business knowledge and skills requirements are an important starting point on which to change attitudes and behaviour currently militating against female participation in entrepreneurship.

Bridging the Gap: Education to Encourage More Female High-Tech Entrepreneurs

Education (in its broadest sense) should stimulate enterprising behaviour as it provides individuals with a sense of autonomy, independence, and self-confidence (Garavan & Ó Cinnéide, 1994). These qualities are important when starting a business (Deakins & Freel, 2003). Education broadens the horizons of individuals, thereby making the student better equipped to perceive opportunities in the environment around them. Education should make people aware of alternative career choices, and one such alternative should be self-employment. Findings reported by GEM (2004) suggested that the

Irish educational system did not have a developed or focused strategy to expose students sufficiently to entrepreneurship as a career alternative.

Technology Education

Within engineering and technology programmes, it is important for the student to be educated in a variety of subjects ranging from mathematics, to engineering, to design. Students must be able to move from a fundamental understanding of their subject, the underlying science, to its conversion and practical application into a product that is useful to and used by the end user. Different foci of technology can be studied. For example, in studying information technology, different viewpoints can be taken such as the study of hardware, software, and/or the societal effects of information technology. Our experiences as teachers and researchers in information technology and entrepreneurship indicate the need for the introduction of new subject areas focusing not just on knowledge, but also on skill acquisition. Group work providing students with the basis of working in teams is important. Problem solving and decision making are other skills that need to be developed.

Entrepreneurship Education

Entrepreneurship education should adopt an integrated approach and make enterprise courses available across disciplines (Fleming, 1999; Hynes, 1996). This interdisciplinary approach encourages the use of interdisciplinary student teams comprised of non-business and business students working together. This interaction provides students with a very real-life experience and enhances not just knowledge acquisition, but also skills development in the areas of communication, negotiation, conflict management, and project and people management.

Entrepreneurship education is process driven, and the process needs to consider three central players: the students, teachers (trainers), and business community (Daly, 2004; Hynes, 1996). Linkages between all three ensure programmes are balanced between theory and practice. As the three players have evolving and changing needs, all of which must be considered, this requires a level of integration and flexibility and the delivery of effective programmes.

Integrating Entrepreneurship and the Technology Disciplines: The Issues

Programmes in entrepreneurship and technology are often delivered separately. This article proposes an integrated education programme incorporating both these disciplines, focusing on how more females may be encouraged to choose E&T education and ultimately pursue high-tech self-employment as a career option. We propose linking both sets of programmes, thus providing the student with technical and subject-specific knowledge with the complementary skill sets of entrepreneurship.

The aim of entrepreneurship and technological education should be to encourage female graduates who are capable of being innovative and can recognise and create opportunities, take risks, make decisions, analyse and solve problems, and communicate clearly and effectively to evaluate self-employment as an alternative career option.

Proposed Programme Framework

Our involvement in programmes providing technology to women (Richardson et al., 2002) and in entrepreneurship education (Hynes, 1996) has given an insight into the educational requirements for female E&T entrepreneurs. Starting a new business involves more than the development of a final product or service; rather, it encompasses a series of stages, which link together, that are managed in a subjective way by the entrepreneur and are influenced by a number of factors both personal and situational. From an E&T perspective, students must bring prior knowledge and learn new content. The proposed educational framework and process model, adopted from Hynes, acknowledges these elements, and in doing so, directs the design of a more appropriate and targeted educational initiative to foster increased entrepreneurial behaviour in female E&T graduates. Hynes proposed that initiatives for women must focus on more than tangible learning outcomes. They should focus on personal development, confidence building, self-esteem, and general decision-making and management skills. It is considered that these skills are very important to encourage greater female participation in both technology and engineering disciplines and self-employment.

Figure 1. Proposed framework of high-technology entrepreneurship education (Source: Modified from Hynes, 1996)

Inputs	**Process**		**Outputs**
Students	**Content Focus**	**Teaching Focus**	**Professional/ Technological**
Prior knowledge base Motivation Personality Needs/interests Independence Attitudes Parent influence Self-esteem Values Work experience	Science/mathematics Information technology Engineering design Usability Entrepreneurship defined Intrapreneurship Innovation New product development Idea generation Market research Finance Production technology Intellectual property rights People management Teamwork Business Marketing	Didactic (reading/lectures) Skill building (case studies, group discussions, presentations, problem solving, simulations, teamwork, projects) Discovery (brainstorming, personal goal setting, career planning, consultancy)	Personal (confidence, communication) Knowledge (enterprise, initiative, self-employment, business, management and market skills, analytical, problem solving, decision making, communication, presentation, risk taking) Career (improved knowledge, broader career options, broader and less structured career perspectives).

The modified process model includes high-technology content (Figure 1). We can see that, mainly through the teaching focus, these skills must be integrated with and not separated from the content focus, thereby converting the students' inputs into professional technological outputs (both tangible and intangible). The proposed framework indicates the key areas to consider, and acknowledges that it may need to be modified to accommodate the specific characteristics of the different target groups, different regional characteristics, and different environmental conditions. The flexibility to adapt the framework to the needs of the situation is a key determinant in its effectiveness.

The personal profiles and personality characteristics of the inputs or students are important and should be defined before the content or teaching focus is finally decided upon. It is at this stage that many of the aforementioned obstacles discussed can be accounted for and accommodated in the content, teaching, and delivery processes. A useful method of ensuring that these details are collected is through the completion of an entry questionnaire. This assists the students to determine their own levels of self-awareness and interest in both disciplines.

As female participation in E&T is not occurring naturally—that is, women are not considering E&T as a career option at the same rate as males—there must be a continued focus on the promotion of E&T to women through such initiatives. Otherwise, significant female participation in high-technology entrepreneurship will never happen.

The content focus provides students with an understanding of the technology topics and the stages of the entrepreneurial process. Other content-focus topics, such as people management, teamwork, business, marketing, and management, are often not associated with the study of E&T. The provision of these within entrepreneurship modules will add value to the knowledge of necessary business subject areas and also develop the skills base to encourage more enterprising behaviour.

The teaching-process aspect is critical to ensure that the identified skills and knowledge objectives are achieved. The teaching focus should also take into consideration the obstacles that militate against female participation in engineering, technology, and entrepreneurship. Therefore, the focus should combine both formal and informal teaching methods, and also encourage topics such as problem solving and career planning. The teaching focus should provide students with the knowledge of not just what to do, but how to do it. The teaching can be delivered through the use of case studies, the inclusion of guest lecturers, and the use of role-plays and project work, all of which have been effective in our teaching to date.

The combination of content and teaching elements provides students with an understanding of the stages of the entrepreneurial process. The completion of a business plan in an interdisciplinary team provides the student with a practical and realistic insight into how self-employment in the E&T field can at some stage be a career option for them.

Given that the inputs, content, and teaching are provided through the initiatives discussed in this article, we expect that a combination will give the desired outputs. We therefore consider that the integration and linking of these types of programmes will result in key initiatives through which we can provide the inputs through the effects of E&T initiatives, and the content and teaching focus through entrepreneurship education. This will provide female graduates with personal, knowledge, and career requirements, facilitating them to become high-technology entrepreneurs in the E&T arena.

We are aware of the need for positive interest and entrepreneurship education for both male and female students. While the same type of programme can be applicable and relevant to both genders on a generic basis, the promotion of female entrepreneurship in E&T sectors requires some level of customisation in content and delivery methods to cater for the more specific attitudinal and confidence issues that tend to be more prevalent with female students. We suggest that programmes to foster female E&T entrepreneurship can be adopted to suit most school curricula and can have positive benefits for both disciplines.

CONCLUSION

This research adds to the ongoing debate on the issues and barriers associated with female entrepreneurship in the high-technology sector by addressing what are considered the source of the problems. It further discusses how the promotion of E&T initiatives can support the development of high-technology female entrepreneurs. Suitable interventions catering for both disciplines can and should be developed. In the development and implementation of the process framework for high-technology entrepreneurship education, we have considered some of the key priority issues that need to be addressed in future entrepreneurship programmes for female students.

The development of such initiatives could have broad applications, may assist in reversing the trends presented in Fitzsimons et al. (2003), and can contribute in the long term to the pool of female Irish entrepreneurs willing to and capable of starting high-technology companies.

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KEY TERMS

Education: Education broadens the horizons of individuals, thereby making students better equipped to perceive opportunities in the environment around them.

Engineering & Technology Courses: Courses whose focus is an area of engineering and/or technology. Such courses include, for example, electronic engineering, computer science, information technology, and manufacturing engineering.

Entrepreneurship Activity: The number of individuals who consider starting a new business and those who actually start and manage an established small firm.

Entrepreneurship Education: Process of providing students with the understanding, knowledge, and skills required to develop and manage a new business.

Glass Ceiling: The unofficial barrier that is perceived as making it more difficult for minority groups, such as women, to achieve career advancement to management.

Role Models: In this context, people who younger individuals or those with career aspirations can identify with, look up to, or get advice from.

Second-Level School System in Ireland: Students enter the second-level system from 12 years of age onward. Students complete a minimum of 5 years of study and exit with a leaving-certificate qualification, usually in at least 7 subjects. These subjects normally include Irish, English, mathematics, often a European language, and three other subjects chosen by the student. The students can write either a higher or ordinary-level paper in each subject.

Technology Education: Process that develops the student's fundamental understanding of the subject—the underlying science—into a product that is useful to and used by the end user.

Career Management Concerns for Women in IT

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INTRODUCTION

Frequently researchers cite the perceived masculinity (Ahuja, 2002; Muryn Kaminiski & Reilly, 2004; Trauth, 2002) of information technology (IT) jobs as one of the main reasons that more women are not in the field. Such a diagnosis, while helpful for strategizing plans to attract new women into IT, does not address the needs and concerns of women currently in IT positions. These women are already aware of the degree to which IT is a masculine profession. They have entered the field in spite of this because they have a natural affinity for the work, found a niche that is comfortable for them, or developed a coping strategy. While these women may have overcome important barriers to enter the profession, entry does not constitute the last hurdle that they will have to face in their careers.

Certainly, the path for women intending to make a career in IT is an uphill one. One only needs to look at the disparity between the numbers of men and women working in the industry (United States Census Bureau, 2005) to sense that the playing field is not level. While acknowledging that women are overtly discriminated, it's important for women to become aware of the unintentional ways they are discriminated against, how they may inadvertently contribute to this, and possible methods for overcoming it.

Specifically, the authors will discuss how inadequate social networks, skill obsolescence, and limited vertical/internal job mobility present challenges to career success. While not unique, these challenges are more tangible and pervasive barriers to career success for women in IT. Also, while other scholars have identified similar career hurdles for women in IT (Ahuja, 2002), the current discussion differs from past scholarship in several key areas. First, these issues are discussed with an emphasis for women once they have started their careers and not their initial career choice. Second, each section includes a vignette that provides an example and context explaining the underlying processes. Third, the paper goes beyond diagnosis and explanation to offering specific strategies for overcoming these barriers.

INADEQUATE SOCIAL NETWORKS

The local team (it doesn't matter what sport) just played an incredible game, Tom who is a big sports fan can't believe they pulled it out and are in the playoffs, as he sits down to the meeting with Sally and their manager, Alex, he asks if either caught the game over the weekend. Sally says no. But Alex and Tom start talking about key plays, bad calls, and their favorite players. Eventually they settle down to the meeting, but Alex decides to continue the conversation over lunch, as Sally wasn't a part of this conversation she wasn't invited. Its not that Tom and Alex don't like Sally or don't think she's talented, it's just they're talking sports so don't think to include her along. Unfortunately for Sally, Tom and Alex get into the habit of going out to lunch. As a result, Sally misses critical opportunities to bond with her manager and doesn't build the same relationship with Alex that Tom has. So when it comes time for promotion or assigning an important project, to whom does it go? While there is no conscious intent to discriminate against Sally, it is just that Alex, like most people, wants to see his friend do well. So all else equal, Tom is more likely to get the high profile assignment or promotion. Further, seeing the old boy's network at work once again, *Sally is more likely to feel disenfranchised and more apt to consider leaving the organization.*

While this vignette describes a single example, the basic facts are repeated over and again for both men and women. Companies like hiring and promoting individuals with personal connections because those personal connections provide greater assurances that the individual will fit into the culture. These personal connections, even if not work related, can also create a sense of mutual obligation and trust. Assuming that all else is equal in terms of work quantity and quality as well as future "promotability," why take a chance on Sally when the management team already likes Tom? This similarity selection bias has been explained and documented in both the psychological (Schneider, 1987) and sociological (DiMaggio & Powell, 1983) literatures.

Because of the gender composition of the workforce, this represents a particular problem for women in IT. The percentage of women among all IT workers varies between 20 and 30% for most IT jobs (US Census Bureau, 2005). Accordingly, this classifies women in IT jobs as a minority rather than tokens (Kanter, 1977). This means that there should be sufficient number of women to create gender-exclusive networks, making it more challenging, but not impossible to create such networks. Women in organizations or professions where they are tokens would, ironically, not have the luxury to create such networks and may by necessity create cross-gender relationships.

So women can improve their outcomes by starting to read the sports page, right?

Not exactly/completely. Developing an interest in sports won't help unless the rest of the conversation changes. Women need to be more strategic when deciding with whom they should develop relationships within their organization. Research has shown that women, in male dominated organizations, and minorities who have more demographically diverse networks generally experience greater levels of career success (Cox, 1994; Ely, 1994; Ibarra, 1995).

Managers can also help compensate for this phenomenon. One organizational strategy would be to take advantage of the potential of diversity training. If men and women in the organization become conscious of how their default conversational topics can impact careers, they have a greater chance of changing communication patterns and thus promote cross-gender relationships (DeJanasz, Dowd, & Schneider, 2002). This requires that organizations develop training strategies that go beyond mere compliance issues.

Another way that an organization can help overcome this networking problem is by developing a mentoring program (Cox, 1994). Research has shown that mentoring improves the career outcomes for the protégé. Mentors improve employment outcomes for individuals by helping their protégés with career planning, acting as role models, navigating organizational politics, and providing the protégé with access to their own social networks. While the networking function is only one of many ways that the mentor contributes to the career success of the protégé, it's the function most relevant to the current discussion.

While mentoring programs have, in general, been shown to be effective, the overall success rate of formal mentoring programs is relatively less than informal ones (Chao, Walz, & Gardner, 1992; Ragins & Cotton, 1999). Unfortunately, given the issues involved in the formation of personal networks the likelihood of large numbers of women entering into informal mentorship programs with men seems remote. Still, organizational intervention with a formal program is preferable to no program.

While mentors and protégés that share common interests will develop stronger relationships, organizations should be careful about the obvious matching of men with men and women with women. This is not to say that a woman would not make a good mentor for another woman, just that a main reason for instituting such relationships is to help overcome the cross-gender networking problem. Selecting women as mentors is perfectly okay as long as the potential mentor has a diverse/powerful social network. Otherwise, all else equal, a potential female protégé could arguably benefit more by being paired up with a male mentor, as this would address the important cross-gender networking concerns.

SKILL OBSOLESCENCE

While who you know might get you into a specific position, what you know will keep you there. Thus another key challenge for women in IT is the threat posed by skill obsolescence. Again, this is not a problem that can be fixed by influencing the choices and academic direction of girls and young women. The rate at which skills become obsolete is faster for IT workers relative to other professions, making this a greater threat to their careers.

While advanced training is the obvious answer to this problem, the implementation is not that simple. The provision of training in IT is complicated by the tendency that required skills are either general (Becker, 1975) or industry-specific (Derek, 1995) in nature. This means that you can take the programming language you learned at job A and take it with you to job B. Because such training improves the mobility of the individual, employers are reticent about providing it. After all, companies want to protect their investment, in this case your increased skill base. Organizations would not last long if they lost all their best employees as soon as they paid to train them.

One way that organizations have dealt with the portability of such skills is to adjust the investment function so that the cost burden is shifted to the employee. At the most basic level, this is seen in the expectation that applicants for entry-level positions already have bachelors' degrees. Once hired, companies shift the costs to the worker through a variety of mechanisms such as scheduling the training session for non-work hours. Although the employer may pay the tuition costs of training that takes place during non-work hours, they shift costs to the individual by making him or her attend during non-compensable time. This saves the employer from losing productive employee time during the workday and requires the employee to show commitment through a time investment into the training program. This explains why so many training sessions take place in the evenings or on weekends.

So why is the "generalizability of training" a gender related issue? Let's consider Tammy's story.

Tammy works in a technical support position at her company. Because of her high ratings, Tammy is asked if she will attend the vendor's training course. Tammy is flattered, and wants to say yes, but has a problem. The training sessions start at 6:30 and are held an hour east of her office, and that doesn't give her enough time to pick up her kids at day-care. Even assuming that she could work through lunch and leave an hour early, who is she going to get, much less how is she going to pay someone, to watch her kids while at the training? After spending a couple of days trying to figure out a solution, Tammy reluctantly has to go to her supervisor and explain that its not possible for her to attend the training course.

As this scenario shows, it is here, in the scheduling of training programs, that gender plays a role in the ability of employees to update their knowledge and skills. Despite improvements in recent years, society still expects and finds women engaged in the majority of housekeeping duties, regardless of employment status. This second shift that women have to work at home decreases the amount of time available to maintain the currency of their IT knowledge (e.g., Ahuja, 2002). A mother with childcare responsibilities may have trouble finding either the time to engage in training or the money available to pay for additional childcare duties while attending training. This expectation of women's role in society therefore places an additional burden on them to maintain the currency of their job skills. And this problem is particularly acute in IT where the life-span of necessary job skills is relatively short.

Consequently, employers need to make accommodations for women if they want them to continue to be viably employed in the IT industry. There are a couple of different strategies that employers could use that would address this problem. The first solution would involve changing the way that training is offered. Assuming that it is possible, companies could make use of distance learning/computer based training strategies. Utilizing this technology would enable working mothers to train at their own pace whenever they find the time to do so.

The next two strategies, while helpful for many women, are less likely to be implemented because both of them require additional costs that must be either borne by the employer or shifted to the employee. The first of these alternatives is to provide training during the workday. The second option would be either the provision of, or reimbursement for, childcare during the training session. While this does increase the cost of providing training, childcare may be cheaper than the lost productivity from the previous alternative. Alternatively, employers may be willing to accept the costs of childcare as the price of keeping talented women in their IT workforce.

LIMITED VERTICAL/INTERNAL JOB MOBILITY

Many women who work in IT jobs hold positions that require a relatively low-level of schooling. For these women, networking and obsolescence are not their main career concerns. The main category of job in this area falls under the general heading of data entry. Low skilled positions like data entry require very little training and preparation (Jenkins, 1999). While data entry is not the only low skilled IT job in the labor market, this discussion will focus on these workers for numerical reasons. According to recent census numbers, the majority of people in data entry jobs were women. Approximately, 80% of the 581,000 employed (US Census Bureau, 2005) data entry operators are women. The main problem facing women in these positions is largely structural in nature, as the following illustrates:

Dana has been doing data entry work for the past 10 years. In that time, Dana has worked for seven different companies, entering everything from medical records to television rebates. Among the reasons that Dana has worked for some many different employers is that, although she has not gone to college, she is quite bright and gets bored because of the repetition. Learning what different companies do is one of the few things she finds interesting about her job. While her supervisors all have liked her and have been sorry to see her leave, they haven't been able to keep Dana. Although they know she is bright, she doesn't have the skills necessary for one of the entry-level professional IT positions and the company doesn't offer that kind of training. The best these supervisors can do is to suggest that she go back to college. Unfortunately, Dana has neither the time nor the money to do so. So instead of moving up, Dana moves on to the next company.

While the data entry worker can go from one job to another, their careers remain horizontal rather vertical. They tend to move from one data entry position to another, or even in and out of IT altogether, without advancing in organizations. The reason for this is that such jobs exist in relative isolation. Structurally the jobs are not linked to others in organizations. Without prescribed paths it is difficult for managers to work with employees to create development plans that would facilitate upward mobility. Given this problem, and the low skill level necessary to perform their jobs, data-entry workers are often treated as a renewable rather than as a human resource by organizations. Over time, this problem will potentially get worse as organizations' find new ways to automate or outsource data entry. As the number of jobs decrease, women in data entry will have fewer mobility options available to them, which will dramatically increase the level of competition.

To properly address this issue, employers will need to rethink the role of data entry workers in their organization. One way to do this would be to create bridge programs to move data entry clerks into formerly entry-level, now transitional, IT job. Examples of such jobs could include testing, documentation, and help-line specialists. This changes a dead-end job into an entry-level position, and thus the organization increases the desirability of data entry positions. Consequently, this should increase the number of people who apply for new data entry positions, which then allows the organization to be more selective. Therefore, the organization may be able to increase the overall quality of its workforce.

Recruitment and selection of new data entry workers is not the only way that the organization may be able to improve the quality of its workforce. Using an internal promotion system to fill entry-level IT positions should have the effect of increasing loyalty within the workforce, as the organization now provides the opportunity for a career and not just a job. Further, the time spent as data entry workers provides management with a lot of information about who is and who is not a good worker. Consequently, the organization would only promote the best and thus will be able to lower the number of bad hires they make.

CONCLUSION

While conceivably there are many pathways for addressing the imbalance in numbers of male and female IT workers, many of these focus on the IT "pipeline." However, these strategies tend to focus on the short-term, unless supplemented with mechanisms to retain a proportionate number of female workers in the field. As discussed in this paper, entry into IT is only the first of several career challenges that women will need to effectively address.

If the number and percentage of women working in IT is to fundamentally increase for the long-term, it is incumbent on organizations to take the lead and initiate programs and policies that will help foster such an outcome. The organizational strategies provided in this paper are suggestive and are examples of how an organization can demonstrate its commitment to women in IT. These strategies are not exhaustive and each organization must determine for itself how best to promote and retain women given their resources and limitations.

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KEY TERMS

General Skills: Job skills one can use in any employment situation.

Horizontal Mobility: Staying at the same organizational level when taking a new job.

Mentor: Person who provides career guidance and support to a junior colleague.

Network: One's social relations in a business context.

Portability: Ability to apply knowledge in a different context than it was developed.

Protégé: Person receiving career guidance and support from a senior colleague.

Skill Obsolescence: When job skills cease to promote productivity.

Vertical Mobility: Traditional upward promotion process within an organization.

Checking Female Foeticide in the Information Age

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INTRODUCTION

In India, the practice of sex-selective abortion or female foeticide (in which an unborn baby is aborted or killed before birth simply because it is not a boy) is only the latest manifestation of a long history of gender bias, evident in the historically low and declining population ratio of women to men. Moreover, the medical fraternity in India has been quick to see entrepreneurial opportunities in catering to insatiable demands for a male child. Until recently, the technology was prohibitively expensive. The three chief pre-natal diagnostic tests being used to determine the sex of a foetus (sexing) are amniocentesis, chronic villi biopsy (CVB) and ultrasonography. Amniocentesis is meant to be used in high-risk pregnancies, in women older than 35 years. CVB is meant to diagnose inherited diseases like thalassaemia, cystic fibrosis and muscular dystrophy. Ultrasonography is the most commonly used technique. It is non-invasive and can identify up to 50% of abnormalities related to the central nervous system of the foetus. But sexing has become its preferred application. A ban on the government departments at the center and in the states, making use of pre-natal sex determination for the purpose of abortion a penal offence, led to the commercialization of the technology; private clinics providing sex determination tests through amniocentesis multiplied rapidly and widely. These tests are made available in areas that do not even have potable water, with marginal farmers willing to take loans at 25% interest to have the test. Advertisements appear blatantly encouraging people to abort their female foetuses to save the future cost of dowry. The portable ultrasound machine has allowed doctors to go from house to house in towns and villages.

Figure 1.

In a democracy, it is difficult to restrict rights to business and livelihood if the usual parameters are fulfilled. An argument by Rathee (2001) brings to light the fact that the recent technological developments in medical practice combined with a vigorous pursuit of growth of the private health sector have led to the mushrooming of a variety of sex-selective services. This has happened not only in urban areas, but deep within rural countryside, also—areas where the other dimensions of healthcare and development are yet to penetrate. Indeed, the indications are that given these lethal combinations, the phenomenon of sex-selective abortions is growing nationwide. Furthermore, these discriminatory services are being provided and projected in the name of "democratic choice" as a measure of "upliftment" of women, since they are being saved from dowry deaths, burning and other forms of torture and violence they would have undergone once they were born. This pure greed for money is also equated by a large section of doctors to "people's demand."

BACKGROUND

In an age when females have left no stones unturned in almost every field, there are people who still accord a lower status to women. "What's wrong with a girl child? In this era of gender equality, why this sexual discrimination?" In some of our Indian societies, while a childless woman is perceived as incomplete, one who has given birth to daughters is partially complete. Only the one who has produced a son enjoys a status of sorts. The problem is intimately related to the institution of dowry. "If it's a girl child, we will have to spend first on her education and then on her marriage and dowry ... It doesn't stop there. We will also have to meet some of her expenses after marriage. How I wish I get a son!" The bias against females is also related to the fact that sons are looked at as a type of insurance. Even our religions have been prejudiced against women. According to Manu (2000 BC-2000 AD), a woman has to be reborn as a man to attain moksha (redemption). A man cannot attain moksha unless he has a son to light his pyre. Also, it says a woman who gives birth to only daughters may be left in the 11th year of marriage. This obviously shows the gender bias in our male-dominated, patriarchal society.

FEMALE FOETICIDE AND LAW

There has been an inability to discuss the issue of foeticide without the larger debate on abortion, which is legally allowed and has been seen as a triumph of the women's rights movement in the country. India has allowed abortion on broad medical and social grounds since the Medical Termination of Pregnancy (MTP) Act was passed in 1971, further trivializing the issue of foeticide. The Pre-Conception and Pre-Natal Diagnostic Techniques (Prohibition of Sex Selection) Act and Rules 1994 (as amended up to 2002) (the PCPNDT Act), a result of determined action by NGOs against grossly unethical medical terminations of healthy pregnancies, mandates that sex selection by any person, by any means, before or after conception, is prohibited. But while the Act seeks to regulate and prevent misuse of pre-natal diagnostic techniques, it rightly cannot deny them, either. The PCPNDT Act allows pre-natal diagnosis only for chromosomal abnormalities, genetic metabolic disorders and congenital abnormalities. The law, however, permits ultrasound clinics, clinics for medical termination of pregnancies and assisted reproductive facilities as a routine matter and legitimate business. Then there is the legally binding Code of Medical Ethics, constituted by the Indian Parliament in the Medical Council Act (1956) that many doctors conveniently ignore. Doctors are legally bound to report medical malpractice. The PCPNDT Act mandates that any person conducting ultrasonography or any other pre-natal diagnostic technique must maintain proper records. The Act requires use of a written form, duly signed by the expectant mother, as to why she has sought diagnosis. Violations are punishable by imprisonment and a fine. The law also permits abortions for failure of contraception. It is a huge challenge for the government to detect violations of the PNDT Act, since it is a crime of collusion and by consensus.

The Ground Reality

Female foeticede is now more widespread in the country than ever before. The practice that was restricted to a few states a few years ago has now spread all over the country. Not only the poor, but even the middle classes and the rich in India are biased against the girl child and women. The provisional figures of Census1 2001, which have frightened even the Health Department, show that the Child Sex Ratio (CSR, the number of girls in the age group of 0 to 6 years per 1,000 boys of the same age group) has declined sharply from 945 females per

Table 1. CSR and OSR

	1951	1961	1971	1981	1991	2001
CSR	983	976 (-7)	964 (-12)	962 (-2)	945 (-17)	927 (-18)
OSR	946	941 (-5)	930 (-11)	934 (+4)	(927-7)	933 (+6)

Source: Census of India

1000 males in 1991 to 927 females. Furthermore, the CSR is actually worse than the national average in Himachal Pradesh, Punjab, Chandigarh, Uttaranchal, Haryana, Delhi, Rajasthan, UP, Gujarat, Maharashtra and Daman and Diu. The Overall Sex Ratio (OSR, which looks at the ratio of all females to males, not just those in the 0-6 age group) is even worse in places like Chandigarh (773:1000), Delhi (821:1000) and Punjab (874:1000). Health experts say these are some of the lowest sex ratios in the world. Here is a paradox. During the final decade of the last millennium, the CSR recorded its highest fall, dropping 18 points from 945 to 927. However, during the same decade, the OSR recorded its highest gain, rising 6 points from 927 to 933. In every census since 1951, the two ratios have gone more or less hand in hand, dropping steadily except in the late 1970s (see Table 1 below). The sudden fall in the number of girls in the youngest age group is believed to be proof of the increased incidence of sex-selective abortions or female foeticide. Most of these abortions are the result of the misuse of sex determination technologies, such as ultrasound scanning and amniocentesis.

What is a woman's role in all this? Whether in choosing her spouse, contraception methods and the first pregnancy, place of delivery and so forth, does her choice or decision really matter at all? Or is it really possible for a woman to decide about having an abortion, if she has to survive as a daughter-in-law in the family? Let's assume her husband supports the birth of a female child; even then, she will prefer to have a male child to get respect from her in-laws family, in order to save her marriage.

- Mrs. A from Jalandhar district was married in Chandigarh. Both the husband and wife are highly educated (post-graduates). The husband earns a salary of Rs.4,000 per month. At present they live in a joint family consisting of the father-in-law, mother-in-law, brother-in-law and his wife. The brother-in-law has a 13-year-old only son. All the members are highly qualified—one of the brothers-in-law and his wife are doctors and live separately. Mrs. A has one daughter. She conceived a second time after keeping a conscious spacing of three years. In the fifth month of pregnancy, she went for amniocentesis and found the foetus to be a female. She did not reveal this to her in-laws, but secretly, with her husband's consent, she underwent an abortion. The researcher was able to contact her before the event, and found Mrs. A to be depressed and pale with fear and the guilt of having conceived a daughter. Sobbing, she said that she was ashamed of having a female foetus. While her husband did not mind having a daughter again, she herself wanted to have only two children, and to earn the respect of the family, she presumed that it is important to have a son. What a dilemma!

If a woman doesn't have any say in this matter, don't you think that this forced female foeticide is an act of violence against women? So where is the cure of this disease? With law? Doctors in India believe 2 million foetuses are killed every year through abortion, simply because they are female. Although it is an illegal practice, with the increasing availability of sex determination tests, it is impossible to keep track of such cases. There is little doubt that in India the PCPNDT Act of 1994 has not been very effective. The facts revealed by the census speak for themselves. We need, rather, to attempt more broad-reaching strategies that will address the economic and cultural roots of the problem. What is required is that the available legislation for prevention of sex determination needs strict implementation, alongside the launching of programs aimed at altering attitudes, including those prevalent in the medical profession. In rural areas, as the number of marriageable women declines, men would tend to marry younger women, leading to a rise in fertility rates and thus a high rate of population growth. The abduction of girls is an associated phenomenon. It was recently reported in *The Hindustan Times* that young girls from Assam and West Bengal are kidnapped and sold into marriage in Haryana. It is only by a combination of monitoring, campaigning and effective legal implementation that the deep-seated attitudes and practices against women and girls can be eroded.

Girls and women not only face inequity and inequality, they are even denied the right to be born if their families do not wish so. In fact, many families do not wish their women folk to deliver baby daughters. Confronted with this situation, it is high time to take preventive measures against female foeticide. Both local leadership and government agencies should plan a concerted long-term program aimed at the educational and socio-economic advancement of the community—for example, by social welfare and poverty alleviation programs—to improve the economic status of women. To wean people away from the traditional practices, voluntary organizations should come forward to promote social education and awareness among the people through cultural programs, public debate and so forth. There is a need for sustained campaigning and active monitoring of the act. State governments should realize the importance and priority of the law and not merely treat it with their usual complacency. Structures for implementation of the 1994 law need to be created at the district level. Volunteers have to be actively mobilized to monitor registration and functioning of sex determination clinics at different districts. Cases have to be filed against the violators and social consciousness has to be raised against the crime. Members of society and religious leaders have a positive role in creating a morally reformed society. The long-term task is to foster a culture of goodness and human dignity that inoculates individuals and institutions against the infection of this despicable human practice.

INTERVENTIONIST ROLE OF INFORMATION AND COMMUNICATION TECHNOLOGIES

Progress of science and technology is mandatory for the progress of a nation, but what matters most is its manifestation and beneficial application. Today, information technology has changed the communication paradigm, making it no longer difficult to reach a large number of people more or less at the same time; and that, too, enables them to respond, interact as well as obtain a copy of the information within a low-cost. information and communication technologies (ICTs), apart from making people aware of this heinous crime, can also play a highly interventionist role by proactively pursuing cases against erring doctors, booking them under the law of the land as well as helping people in general change their opinion about a “girl child.” An important tool helping the government of India accomplish their cherished goal of altogether stopping female foeticide, set up by Datamation Foundation Charitable Trust, is a Web site solely dedicated to Female Foeticide (www.indiafemalefoeticide.org). This major ICT-based campaign and advocacy program is to help prevent occurrences of sex-selective tests and selective abortions of female foetuses in India. The purpose is to mobilize the population that apparently wants female foeticide, a medical system happy to supply the necessary technology, and a section of feminists arguing that female foeticide is about reproductive rights and choices.

FUTURE TRENDS

Online Attempts to Check Female Foeticide

The India Female Foeticide portal includes some distinctive features. The “Femicide” section provides some rich background information on the prevalence and practice of Female Foeticide, including reasons for the sex-selective tests. The site not only covers the regulatory aspects—PNDT Act of 1994 and the Medical Council of India’s code of conduct to crack down sex selection – but also includes a complaint-lodging process in the best tradition of e-governance. The complaint-lodging process is a very critical feature, as it protects the identity of the complainant and yet provides an effective vehicle for booking the doctor, maternity home, ultrasound clinic or radiology clinic. The complaints are retrieved into a database format at Datamation, where they are handed over to the central PNDT Cell (Ministry of Health and Family Welfare) and other respective state and district authorities for re-addressal. To date, the Foundation has received about 580 complaints, and has passed these to respective authorities. The interpretation of the law in form of demographic data is also put on the Web site. Another important platform for the Web site is the “Pledge Support” page, which highlights two features—Pledge Support and Information. Through the “pledge support” feature, one can enter information regarding the type of volunteer service the person or the organization is ready to offer, and the "information" option allows one to enter information about any ultra-sound clinics, doctors, radiologists and so forth to enable database building.

Serving as a knowledge repository on the issue is the "What's New" page. The attempt here is awareness generation and capacity building both among the community and the stakeholders. Through e-mails, to date the Foundation has succeeded in spreading awareness among 8 million people worldwide on this issue. The "Links/Resources "page contains the contact addresses of different NGOs and agencies working for the prevention of female foeticide, and gives data for state-wise, sex ratio and female foeticide and sex selection. To enable awareness generation through sound and visual media, radio and video links have also been added to the Web site. An important feature started under this initiative is the e-Newsletter, through which the Foundation disseminates news, articles, reports and other studies on a weekly basis to make the various segments (students, NGOs, medical community, educationalists, government officials, researchers) of the society aware about issues of gender inequality, female foeticide and sex-selective abortions. "Youth Voices," a newly started section on the portal, is an effort to motivate and encourage youth participation in eradicating this menace and spreading awareness among other groups. To enable communication on this issue among various segments of society, we have started a discussion forum that allows free-flow and exchange of ideas among people.

CONCLUSION

Fully understanding that an evil such as this cannot be addressed in isolation, we are also closely examining related social malaise, such as dowry, women's underemployment and exploitation in society, education standards of the girl child as well as high school dropouts among girls, early marriages and the arranged marriage system. It is our endeavor to develop sustainable development models for each of the above-listed social malaise in India so that these have an impact on improving the ratio of females in the Indian society.

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KEY TERMS

Child Sex Ratio (CSR): The number of girls in the age group of 0 to 6 years per 1,000 boys of the same age group.

Dowry: Money or property brought by a woman to her husband at marriage.

Female Foeticide: Practice in which an unborn baby is aborted or killed before birth simply because it is not a boy.

Manu: The primordial father of the human race and sovereign of the earth who first instituted religious ceremonies and devised a code of laws.

Moksha: In Hinduism, liberation and bliss (nirvana) from the cycle of rebirth (samsara); also called *mukti* or *moksha.*

Overall Sex Ratio: The ratio of all females to males, not just those in the 0-6 age group.

ENDNOTE

[1] When we talk of the Indian Census, it is important to understand that our sex ratio is defined as the number of females per 1,000 men, unlike the West, where sex ratio is the complete opposite and defined as the number of males per 1,000 females.

Childhood Interest in Computers and Adult Career Choices in IT

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INTRODUCTION

A considerable amount of interest in the past several years has been devoted to the characteristics and dynamics of the fast-growing information technology (IT) industry in the United States (U.S.). Particular attention has been focused on how gains from increasing computer and Internet use are distributed across society. Do all segments of society enjoy the same level of access and use of computers and the Internet, or do some segments of society benefit more from computer and Internet use than others? This question has engaged a widespread and prolonged debate surrounding the issues of fairness of IT participation and use in the U.S. By the same token, many in recent years have also focused on how *interest* in IT and computer and Internet use are distributed across society. In this article, I focus attention on gender participation in IT: Are there differences in both interest in IT as a profession, and computer and Internet use across the U.S., and do these differences persist among young people? While there is considerable evidence that gaps in Internet access and use by gender have largely disappeared (Mossberger, Tolbert, & Stansbury, 2003; Companie, 2001; Norris, 2001; Warschauer, 2003), there is a growing concern that differences in interest in the IT industry by gender are, in fact, widening.

Although evidence suggests that the societal gender gap in Internet access and use has largely disappeared, a gender gap in IT professions still exists and, in fact, is widening. Measuring the magnitude of the gap is complicated because there are varying definitions as to which occupations comprise the core IT professions. Using data from the U.S. Department of Commerce, Current Population Survey (CPS), Meares and Sargent identify four core IT occupations: computer scientists, computer engineers, systems analysts, and computer programmers (1999, pp. 3-4), while The Council of Economic Advisors identifies five core IT occupations: electrical and electronic engineers, computer systems analysts and scientists, operations and systems researchers and analysts, computer programmers, and computer operators (The Council of Economic Advisors, 2000, p. 3). Assuming that working in an IT occupation constitutes interest in the field, then if the level of participation among women in IT declines, presumably, so does their interest in the IT industry.

BACKGROUND

The statistics on changes in the participation rate of women in the IT professions are ominous. The Council of Economic Advisors reported that female participation in core IT occupations had actually been declining since 1986, when it was 42.2%. Within the core IT occupations, women were even more underrepresented within the high-paying electrical and electronic engineering occupations, comprising only 10.1% of the workforce (Council of Economic Advisors, 2000). According to the latest research in the IT workforce, *Untapped Talent: Diversity, Competition, and America's High-Tech Future*, just released by the Information Technology Association of America (ITAA), the number of women making up the U.S. IT workforce fell 18% in 8 years. Last year, women accounted for 32% of the IT workforce, down from a high of 41% in 1996, while during the same time the percentage of women in the overall workforce was virtually unchanged, at approximately 46% (ITAA, Executive Summary).

The literature shows that differences in interest, access and use of IT, and attitude toward IT (Mossberger, 2003) are generally very complex and reflect society's choices in work and leisure activities, which depend on educational, social, institutional and cultural backgrounds (Warschauer, 2003). To more fully understand the underrepresentation of women in IT professions, the dynamics of choice that lead people to these professions must be examined. Ultimately, career choices are affected by a broad range of factors that have historical, cultural, geographical and environmental dimensions.

Many argue that adult interest in IT is determined in large part by the nature and level of exposure to the discipline as a child. Therefore, examining interest in IT among children and, in particular, girls, can serve as a major predictor of future career choice in an IT field. To measure the level of interest in IT among children, the level of Internet use can serve as a proxy indicator.

Interest in IT Among Children

Understanding the relationship between gender, career choices and the world of IT should begin with an exploration of the level of interest in IT among young people. The level of interest in IT acquired at an early age, in part, determines the level of interest generated in the adult's world. The level of interest in IT among children is based on a wide array of both internal (peer, adult, home related) and external (environmental, economic, social) factors.

Earlier research indicated that among both adults and children, females were less likely to use the Internet than males (see Attewell & Battle, 1999; Baumgarten, 2003; Corporation for Public Broadcasting, 2003; DeBell, Matthew, & Chapman, 2003; Haugland, 1992; Mengel, 1995. Hoffman pointed out that women were less likely to use the Internet than men, and that age, education and gender all affect the levels of Internet use (Hoffman, 1996).

From a societal perspective, empirical evidence shows that the existence of disparities in computer and Internet use, a "digital divide," (O'Malley, , 1999, pp. 86-87) has generally been shrinking over time for certain groups, such as women, while expanding for others. According to the U.S. Department of Commerce National Telecommunications and Information Administration (NTIA), the Internet use penetration rate in society, overall, has grown from about one-fourth of all households (26.2%) in 1998 to over one-half (54.6%) in 2003 (NTIA, 2004).

More current research now suggests that computer and Internet use among girls has caught up significantly to that of boys and that gender inequality has all but disappeared. Anderson, Bikson, Law and Mitchell (1995) point out that gender access inequality had largely disappeared by 1993, while Attewell and Battle (1999, p. 4) cited the 1994 *Times Mirror* survey, which suggested that home computer use among girls is not that different than for boys.

The Internet use penetration rate for both males and females has continued to increase since data have been reported. Not only have reported Internet use rates for males and females nationwide remained similar from 1998 to 2003, the reported rates for females actually surpassed that of males in 2003. Internet use rates from any location for males and females increased from about one-third of all households in 1998 (34.3% for males, 31.4% for females) (NTIA, 1998) to more than one-half in 2003 (58.2% for males, 59.2% for females) (NTIA, 2004).

Recent Study Findings

A study conducted by Cleary, Pierce and Trauth (2005) examined the dynamics of disparities of Internet use among school age children in the U.S. The study consisted of examining demographic, socioeconomic and geographic differences in Internet use among children using data from the September 2001CPS Computer and Internet Use Supplement (Cleary et al., 2005).

Principle results show that, not surprisingly, a broad range of interrelated demographic, socioeconomic and computer resource factors were important determinants of Internet use among school-age children, regardless of gender, but among other important findings, Internet use did not differ by gender. In fact, the Internet use of girls 6-17 years of age slightly outpaced that of boys. Results show that Internet use among boys (62.2%) was slightly outpaced by that of girls (63.7%) (Cleary et al., 2005).

Demographic Factors

The underlying household factors that affect the level of Internet use and interest in IT among school-age children are both numerous and complex. The study found that five key factors had the greatest effect on Internet use among children and potentially on interest in IT: the age of the child, the race and ethnicity of the household reference person[1], the gender of the household reference person, the geographic location of the household and the ownership status of the family's residence. In terms of these factors, the largest disparities in Internet use among school-age children were found among children from Black, Hispanic and non-citizen households.

Study results show that there is currently no significant difference in Internet use among boys and girls (age 6-17) across the U.S. Internet use from any location was defined as either in-home or out-of-home use. While in-home computer and Internet use consists of one or more PCs or laptops located in the home, out-of-home use consists of use in schools, libraries or community access centers (CACs) (Cleary et al., 2005). By 2001, CPS survey results of children 6-17 years of age indicate that, regardless of gender, two out of every three children used the Internet somewhere.

This highlights an emerging pattern of use among children. Earlier survey results from 1998 indicate that although Internet use penetration rates for society overall were only about one-third (32.5%), they were equal for both boys and girls 6-17 years of age (35.6% for males, 35.3% for females, respectively) (Cleary, 2001).

On the other hand, significant differences in Internet use by school-age children were found depending on the gender of the household reference person. Survey results indicated that Internet use levels among school-age children were significantly higher in male-headed households (66.6%) than female-headed households (59.1%) (Cleary et al., 2005). Therefore, children from female-headed households reported significantly lower levels of Internet use than male-headed households, or households consisting of married couples. This indicates that perhaps female-headed households are less able than male-headed or married households to provide and maintain Internet resources, including hardware, software, online access, expertise and support for their children, regardless of gender.

Socioeconomic Factors

The results also showed that certain underlying socioeconomic factors, such as level of education, household income and marital status of the household head, are important determinants of Internet use among school-age children. These results indicate in part that lower levels of Internet use were found among children living in households with lower levels of income and education and in households where the household head was either divorced/separated (58.2%) or never married (41.5%). Not surprisingly, Internet use among children was highest among those households where the reference persons were well educated, had high incomes and were married (66.8%) (Cleary et al., 2005). These results are consistent with those from the 1998 CPS survey of computer and Internet use, which also showed that use in female-headed households (22.3%) lagged that of both married households (37.6%) and male-headed households (25.4%) (NTIA, 1999).

Socioeconomic status (SES) (Pediatrics, 2000, p. 1350) is positively associated with income, education and wealth, and therefore, with computer and Internet use in the home. This, in turn, is positively associated with level of use in the home by school-age children. SES tends to be lower for single-headed households, whether male or female, than households in which there are two adults present. Consequently, children from female-headed families, regardless of gender, are less likely to access and use the Internet than households headed by either two parents or a male, because many are unable to afford computing resources and expertise. Results show that Internet use rates among children climb dramatically with both the level of education of the household reference person and with family income. As Cleary et al. (2005) point out, a comparative advantage among children who live in such households is realized because of the effects on Internet use of increasing levels of available workplace human capital. When parental and peer support, both formal and informal, are available, children regardless of gender tend to learn the Internet more thoroughly than in households where no home computer is present and such support does not exist.

FUTURE TRENDS

Available Computing Resources and Expertise

Results showed that the most important factor influencing the level of Internet use among school-age children is the presence of computing resources and expertise available in the household. These resources include computer hardware, software, service providers and an adult in the household able to provide expertise and support to children. This factor has the single largest impact in reducing disparities in Internet use among children, and therefore is crucial in maintaining gender equity in use among children, regardless of SES. Not only is the presence of computing resources in the household a huge positive influence in computer use among children, but the availability of computing expertise and support among adults who use the Internet either at home or outside the home is great as well. Skilled adult household members bring significant amounts of experience (workplace human capital) that can be passed onto their children, regardless of gender.

The results also show that other factors affect use, but their effects are independent. Children from Black, Hispanic and non-citizen households exhibit lower levels of Internet use because they come from lower-income households that often lack at-home computing resources and adults that do not use the Internet either at home or outside the home, and therefore provide no support (Cleary et al., 2005).

These findings suggest that households with computing resources and expertise are much better able to support and encourage children to learn and use the Internet than those without such resources. In addition to the increased availability of in-home computing resources, learning assistance, expertise and support are also readily available to these children. Although the type of support and expertise (workplace human capital) that could be provided to children at home may differ by gender, it is nonetheless transferred to children in these households.

Parental coaching and peer support exert a huge influence on the nature and level of Internet use among children and are influential in impacting both the type and the frequency of use (parents from high SES households provide higher levels of involvement and support in their children's school work) (Schneider & Colman, 1993; Bianchi & Robinson, 1997; Attewell & Battle, 1999). The importance of this support and success in school cannot be understated. Attewell and Battle indicate that there is a close positive relationship between access to home computing and the academic performance of children.

Yet, in spite of the positive affects of in-home expertise, gender interactions can be more complex. Among other effects, Attewell and Battle suggested that fathers can be more enthusiastic than mothers regarding computer and Internet use, and sons are more likely than daughters to program computers. Consequently, although traditional gender roles can be an additional factor affecting computer and Internet use among children, both genders appear to benefit from parental support.

Finally, the strong influence of household computing resources and expertise on Internet use among children also suggests that if computing and Internet resources are available, then guidance and support by an adult (with either in-home or out-of-home access) will occur, regardless of gender.

Availability of School Computing Resources and Expertise

Finally, evidence suggests that the availability of school computing resources and expertise helps reduce the disparities in Internet use among school-age children. The availability of school computing resources provides critical access links to children who come from households that lack access to in-home computing resources. Furthermore, it is particularly crucial for those children living in households where parents do not have access to out-of-home computing resources, either.

A great deal of research has been conducted on the effects of education on interest in the field of IT among young people. Schools play a significant role in gender equity and have helped considerably to reduce the gender gap in Internet access and use among children. For example, Ravitch (1998) argues that schools have been among the leading institutions in creating gender equity in the past generation. When computing resources and expertise are available in school, children without in-home computing resources have a much higher probability of using the Internet and acquiring an interest in IT than when such school resources are unavailable. Also, the benefits of Internet access accrue to both girls and boys, particularly when neither gender has at-home access to the computer and the Internet.

CONCLUSION

Policies that promote interest in IT and Internet use among children from any location need to be fostered everywhere, including those groups currently without any access. If gender equity is to be maintained in society, better Internet access for all children, regardless of socioeconomic strata, is crucial. Computer and Internet access often leads to interest in IT, and interest potentially leads to future IT career choices. If a child is unable to access the Internet, regardless of gender, then there is little chance of developing an interest in computers and Internet technology, let alone mastering its potential. Only by attaining equal access will there be a chance that more children will develop an interest in IT, leading more girls, as well as boys, to future careers in IT.

Because interest in Internet use among both boys and girls is greatest where children have in-home computer access, policy initiatives that promote expanding in-home access should be fostered, since the potential impact on Internet use among children is the greatest. This potential impact to the child includes frequent access to Internet use along with the availability of computing resources and expertise, plus the advantages accruing from the support of parental experience (workplace human capital).

Where in-home access is not available, policies that improve in-school access and use need to be developed more fully. Controlled in-school Internet access locations can potentially help stimulate interest in IT among children, even if only available for short periods of time during the day.

Furthermore, policies are needed to provide funding for Internet access and use at other locations more fully. When the school day ends, access in public libraries or in CACs would provide access alternatives where schools leave off (Cleary et al., 2005). Consequently, computing resources devoted to libraries and CACs also help provide desperately needed computing resources to those unable to access computing resources anywhere else.

To spark interest in IT, technologies that enhance navigation through the Internet, such as providing broadband access to both in-home and out-of home-locations, need to be acquired. Policies offering broadband more affordably to schools, libraries and CACs would enhance Internet access, efficiency and performance, thereby improving the Internet use experience of children (Cleary et al., 2005). In this fashion, interest in IT among both boys and girls stands a better chance of succeeding.

Reducing disparities in Internet access and use among children supports a more equal distribution, and all children will benefit. A more even distribution of Internet access among children, regardless of gender, may improve the probability that girls will develop a deeper interest in IT as a career choice, and ultimately provide future leaders who will strengthen the industry.

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KEY TERMS

Community Access Centers: A public place where a local community can use computers, the Internet or other new technologies. Community access centers can include libraries, schools, community centers and other public access points (NTIA, 1998).

Computing Expertise: Two measures of potential adult computing and Internet expertise: The first is a count of the number of adults (i.e., any person 18 years of age and older) in the household that used the Internet at home, and the second is a count of the number of adults in the household that used the Internet outside the home (Cleary et al., 2005).

Digital Divide: A term used to describe the discrepancy between people who have access and the resources to use new information and communication tools, such as the Internet ("the online haves"), and people who do not have the resources and access to the technology ("the have-nots") (O'Malley, 1999).

Household Computing Resources: A measure of the number of computers in the household coded as 0=no computers in the household and 1.0= one or more computers in the household (Cleary et al., 2005).

Socioeconomic Status (SES): A broad term used to describe factors about a person's lifestyle, including occupation, income and education. It consists of two aspects: one includes resources, such as education, income and wealth; and the other includes status or rank, such as social class (*Pediatrics*, 2000, June 6, 105(6), 1349-1351).

Workplace Human Capital: Human "workplace capital" is a major source of technical expertise that comes from the occupational experience of adults obtained in the workplace. It can be transferred to non-working members of the household, particularly children (Cleary et al., 2005).

ENDNOTE

[1] **Reference Person:** The first household member mentioned by the respondent, who is the owner or renter of the sample unit. For persons occupying the sample unit without payment of cash rent, the reference person is the first household member listed who is 15 years of age or older (CPS, Basic Monthly Survey, Chapter 3, CPS Demographic Data, Bureau of Labor Statistics and Bureau of the Census, p. 6).

C

Community and Gender in the Virtual Classroom

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INTRODUCTION

Numerous studies have demonstrated that alternative educational experiences, such as online learning, produce outcomes similar to face-to-face instruction provided the method and technologies used are appropriate to the instructional tasks, there is student-to-student interaction, and there is timely teacher-to-student feedback (Verduin & Clark, 1991). However, a meta-analysis of 232 comparative studies conducted by Bernard et al. (2004) concludes that while there is no average difference in achievement between distance and classroom courses, the results demonstrate wide variability. In other words, "a substantial number of DE applications provide better achievement results, are viewed more positively, and have higher retention rates than their classroom counterparts. On the other hand, a substantial number of DE applications are far worse than classroom instruction" (p. 406).

These findings suggest that appropriate instructional design and good pedagogical practices, rather than the computer mediating technology itself, is at the center of effective online education. The growing demand for online learning only increases the challenges associated with designing and delivering effective instruction. O'Donoghue, Jentz, Singh, and Molyneux (2000) note that "The diversity of demand from these client groups therefore has to be matched by a diversity of supply. ... Meeting those requirements means putting the student at the centre of the system, which in itself represents a substantial change" (Section III, para. 6). When considering such a student-centered approach to online learning, the instructor needs to become increasingly aware of the differences among students and how those differences influence the educational experience.

One area of student differences that warrants further consideration in the online classroom is gender, especially since distance education has been extensively marketed to women since early correspondence programs (Kramarae, 2003). "Distance education is ... yet another institution where gender and power differences are constructed, and to ignore the ways that gender is under construction online is to ignore many difficult experiences of real people" (p. 269). von Prümmer and Rossié (2001) go further and declare that, "If gender is not seen as relevant, the system will not be equally accessible to women and men and will offer men more chances to succeed" (p. 137).

BACKGROUND

Online Community

A recurring theme in online education literature is the importance of developing a learning community to foster effective instruction. Palloff and Pratt (1999) call for the development of academic communities in online distance classes and declare, "without the support and participation of a learning community, there is no online course" (p. 29). In a similar vein, Moller (1998) writes that "the potential of asynchronous learning can only be realized by designing experiences and environments which facilitate learning beyond the content-learner interaction. To that end, it becomes necessary to create learner support communities" (pp. 115-116). Such online learning communities provide a framework for social reinforcement and information exchange while girding the learning experience with academic, intellectual, and interpersonal support.

Garrison, Anderson, and Archer (2001) endorse this view for the virtual classroom by noting community is extremely valuable, if not essential, in the development of higher-order learning because it provides the social context in which learning occurs. Students strengthen their learning by listening and interacting with faculty and other students. Moreover, strong community promotes the creation of partnerships for study groups and collaborative learning. Wegerif (1998) reports the social dimension of online learning to be an important predictor of the success of the distance learner. He concludes that forming a sense of community is a necessary first step for collaborative learning, without which students are likely to be unwilling to take the risks involved in learning.

Computer-mediated communication (CMC) is needed that fosters cooperation and supports social order at the classroom community level. Gunawardena (1995) observes that "in computer conferences, the social interactions tend to be unusually complex because of the necessity to mediate group activity in a text based environment. Failures tend to occur at the social level far more than they do at the technical level" (p. 148). These failures can include interpersonal conflict, low participation rates, disappointing collaboration, and low learning performances in terms of quality of learning and learner satisfaction. Chester and Gwynne (1998) observe that CMC is associated with higher levels of antisocial behavior, which is the antithesis of the mutual respect that teaching aims to foster and that is required in community building. One contributing factor is the communication pattern differences among members of the community. Lack of respect, inability to listen, and a general lack of sensitivity to others in a CMC environment pose an immense risk to learning.

Fritz (1997) compared organizational peer relationships between men and women and found that while men and women had roughly the same quantity of peer relationships, the relational dynamics differed. She notes that "women's relationships in organizations, similar to what appears to be the case in nonorganizational contexts, have the potential to be stronger and, among very close friends, are characterized by greater strength" (p. 41). Conversely, Fritz found that "men find relationships functional as well, but, socialized to be more independent, they simply do not experience as much closeness in their same-sex relationships" (p. 41). Such findings are consistent with other research (e.g., Tannen, 1991) that highlights differences in communicative and relational patterns between men and women. Such differences are thus likely to have an impact on the development of an online learning community as well as individual reactions to the virtual classroom experience.

Communication Patterns

Belenky, Clinchy, Goldberger, and Tarule (1986) theorize two paths of normal development in adult learning, which result in two different communication patterns: (a) the relational, connected, or interdependent path, which reflects the majority of women (and some men); and (b) the self-sufficient, autonomous, or independent path, which is typical of the majority of men (and some women). This model suggests that many female students place emphasis on relationships and prefer to learn in an environment where cooperation is stressed over competition. The connected voice nurtures classroom community building while the independent voice does not. In particular, the professional literature suggests that most women seek to establish *intimacy* in a relationship, whereas most men seek to establish *status* in a hierarchy, measured in terms of *independence* (Tannen, 1991).

Gilligan (1982) points out that her different voice is characterized by an ethic of caring that men as well as women can espouse. Noddings (1984) elaborates this ethic of caring as "feminine in the deep classical sense—rooted in receptivity, relatedness, and responsiveness" (p. 2). For Noddings, caring is based on reciprocity—one caring and one cared-for—and recognizes "human encounter and affective response as a basic fact of human existence" (p. 4). In this framework, both parties contribute actively to this relationship of caring. Cole and McQuin (1992) identify the following traits of an ethic of care: "a predisposition to nurture, a ready capacity for emotional involvement, a need to be sensitive about relationships and how they generate different varieties of responsibility to others, and a willingness to value particularity, connection, and context" (pp. 2-3).

C

Cognitive Style

Communication patterns may also be related to patterns of thinking or cognitive style. Baxter-Magolda (1992) studied college students' ways of knowing and reasoning. She discovered patterns of thinking that are related to gender and that parallel the communication patterns identified by Belenky et al. (1986). According to Baxter-Magolda, at the absolute stage the learner sees knowledge as held by an external authority. Females at this stage tend to function as receivers, taking notes and studying, whereas males engage in interaction with the instructor. At the transitional stage females are more likely to engage in interactivity, relying on the opinions of others to help construct their own knowledge. Males, on the other hand, are more likely to use the opinions of others as material for debate. Finally, at the independent stage, females have their own interpretations but value interactivity, whereas males tend to rely on independent processing.

Research (e.g., Merriam & Caffarella, 1991) also provides evidence that females tend to be more field dependent while males tend to be more field independent. Witkin, Moore, Goodenough, and Cox (1977) developed field theory to explain differences in cognitive processing and used the term field independence to describe individuals who are individualistic, internally directed, and accept ideas through analysis. On the other hand, field dependent individuals prefer working in groups, are externally directed and more pragmatic, and accept ideas as presented. These differences suggest that females learn better in a personal, practical, hands-on learning environment where feelings and relationships are allowed to develop. Table 1 summarizes major differences in cognitive style by gender based on field theory.

Gender Differences in the Virtual Classroom

Although early CMC literature postulates that the limited social cues found online minimize gender differences (e.g., Kiesler, Siegel, & McGuire, 1984), Herring (1993) claims that online communication is less democratic than proponents tout because gender-based communication styles carry over into electronic environments. Postmes, Spears, and Lea (1998) suggest that CMC does not encourage the liberation of individuals from social influence and general social norms. Instead, individuals tend to engage in heightened stereotypical behavior, conform to group norms, commit to the group, and engage in "us vs. them" behavior given the relative impersonal online environment. Moreover, Inzlicht and Ben-Zeev (2000) report that group composition (i.e., the gender mix of a group) can also trigger stereotype-relevant thoughts and behaviors because group composition can make salient one's social identity and the stereotypes associated with that identity.

Rice and Love (1987) suggest that CMC systems can support socio-emotional communication and the communication reflects the inherent communication patterns of the users. However, text-based CMC lacks many of the interpersonal cues that can provide implicit and explicit information about how others in a group are reacting. In a study examining online communication patterns, Rovai (2001) found significant differences by gender along the lines identified by Belenky et al. (1986). He describes the voice of male messages as tending to be more confrontational, autonomous, certain, abstract, and arrogant. On the other hand, the voice of female messages tends to be more empathetic,

Table 1. Gender-related cognitive style differences

Most Females, Some Males	Most Males, Some Females
Field dependent	Field independent
More likely to use inductive reasoning	More likely to use deductive reasoning
More pragmatic and applied	More abstract and theoretical
Learns best by watching and thinking	Learns best while doing and either thinking or feeling
More organized	More undirected
Connectedness through intimacy and physical proximity	Connectedness through social competition

mention self, family, or spouse, or had a cooperative tone. He concludes that online instructors should be sensitive to the different communication patterns used by their students and should adapt their teaching in ways that facilitate the interaction of diverse groups and accommodate individual and group differences without sacrificing or silencing other members of the learning community.

FUTURE TRENDS

Distance education has become a growth industry as the result of advances in technology and the educational needs of a modern workforce. Carnevale (2005) reports the results of a 2004 study that shows about 937,000 students were enrolled in fully online education programs at the end of 2004. By 2006, more than 1.2 million students are expected to be taking online courses, representing about 7% of the 17-million students enrolled at degree-granting institutions. Distance learners are typically older than traditional students, with the average age over 25 years old, and they are more likely to be female (Ashby, 2002).

Future research should address how best to improve online interactions in order to ensure gender equity. In particular, research is required to better understand how gender-related factors influence the learning environment, educational effectiveness, and student satisfaction. If online instructors are to design and teach using an inclusive student-centered pedagogy, they require detailed information about student differences and how those differences influence learning. For example, in a study of a blended online learning environment, Ausburn (2004) found that females were significantly more desirous of a course which provided an anchor or home base and fostered a sense of belonging and involvement than their male classmates. What other such design factors are differentially preferred by gender?

More importantly, do such differences affect the efficacy of the educational experience or merely the students' enjoyment of the course? Would students enrolled in a course whose design is contrary to their stated preferences learn less or merely find the experience more difficult? In a study of 109 online learners, Anderson and Haddad (2005) found that women reported deeper perceived learning online than in face-to-face courses, largely due to increased comfort expressing their views in class and believing that those views were valued. "Our research suggests that, for females, this greater perceived learning occurs because of the role that voice plays in strengthening perceived deep learning in both online and face-to-face courses" (Section 5, para. 1). They also found that the professor was influential in establishing this confidence and sense of voice among online learners.

The next round of research into gender-related differences in the virtual classroom needs to go beyond stylistic and preference measures to consider cognitive learning. What models of instruction work well for which students and how can instructors develop online learning environments that are equally effective for students from different backgrounds? Such studies will advance the field and help ensure that online learning meets the goals of increased access, learning effectiveness, and student satisfaction (Moore & Kearsley, 2005).

CONCLUSION

The present research-based findings suggest that females and males differ on at least two dimensions that can affect sense of community and arguably learning and learner satisfaction in the virtual classroom. The first dimension is communication pattern (e.g., Belenky et al., 1986; Gilligan, 1982; Noddings, 1984). Females generally communicate using a connected voice that emphasizes socialization, caring, cooperation, consensus, and the indirect resolution of conflict. Males on the other hand, tend to have a more independent voice that emphasizes self-sufficiency, autonomy, and competition. Such communication patterns may be influenced by cognitive style, the second dimension. Research (e.g., Merriam & Caffarella, 1991; Witkin et al., 1977) provides evidence that field dependent individuals, who tend to be females, are socially oriented, externally directed, and more pragmatic. In contrast, males tend to be field independent. A person who perceives items as more or less separate from the surrounding field leans toward a field independent cognitive style. They tend to be individualistic, internally directed, and competitive.

Additional research (e.g., Postmes, Spears, & Lea, 1998) suggests that learners tend to engage in heightened stereotypical behavior in the relatively less personal environment of CMC and online learning. Such behavior left unchecked could give rise to interpersonal conflict resulting in negative feelings, including intimidation, distrust, anger, which eventually can result in a communication breakdown, loss of a community spirit, and decreased learning and learner satisfaction. It is therefore incumbent for the online instructor to be skilled in planning and moderating online discussions.

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KEY TERMS

Asynchronous Learning: Learning in which interaction between individuals occurs with a time delay, allowing participants to receive and respond to communication at a time of their choosing.

Cognitive Style: Consistencies in information processing that develop in concert with underlying personality trends (Merriam & Caffarella, 1991).

Computer-Mediated Communication (CMC): Communication, either verbal or text based, between individuals via networked computers.

Distance Education: Planned learning that normally occurs in a different place from teaching, requiring special course design and instruction techniques, communication through various technologies, and special organizational and administrative arrangements (Moore & Kearsley, 2005).

Sense of Community: Feelings of connectedness, belonging, and trust among a group of individuals and a shared faith that their needs will be met through their commitment to be together.

Virtual Classroom: A location in cyberspace where members of a classroom community meet and interact either synchronously or asynchronously in order to engage in teaching and learning activities.

Virtual Community: A social aggregation that exists in cyberspace when a group of individuals come together, interact, and form personal relationships with each other.

Comparing Gender Differences in Computer Science and Management Information Systems Majors

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INTRODUCTION

Why do so few women major in computer science (CS) or management information systems (MIS)? Are the reasons for women's underrepresentation in these two disciplines the same? I will address these issues by reporting on my research on female and male undergraduates majoring in CS or MIS. I hypothesize that results from one area of information technology (IT), such as CS, do not necessarily generalize to other areas of IT, such as MIS.

Structural barriers exist that keep women from advancement in IT careers (cf. Ahuja, 2002). However, an examination of these is beyond the scope of this article, which focuses on gender differences in IT students. In 2002 only 27.6% of U.S. Bachelor's degrees in CS and 36.8% in MIS were conferred on women (U.S. Department of Education, 2002), limiting the number of women qualified to enter into the IT workforce. The problem of women's under representation in IT is not limited to the U.S. Women are underrepresented in CS majors in other Western countries such as Canada (Gadalla, 2001), Germany (Huber, Reiff, Ben, & Schinzel, 2001), Norway (Berg, Gansmo, Hestflatt, Lie, Nordli, & Sorenson, 2002), and Ireland (MacKeogh, 2003).

IT cannot afford to underutilize such a valuable and significant part of the workforce. Increasing the representation of women is imperative because "greater diversity among those who create computing technology ensures that those technologies are relevant to and usable by a wider range of people" (Roberts, 2003).

BACKGROUND

Both CS and MIS are areas within IT. CS is the more mathematically rigorous and technical major and typically has requirements of advanced physics and mathematics courses. The CS major emphasizes the design, implementation, and management of complex information systems. The MIS major has a more applied focus and concentrates on the collection, processing, and distribution of data for use in decision making in business. The underrepresentation of women is greater in CS than in MIS.

Research on women in IT often implicitly assumes that results gathered in one area of IT will generalize to other areas within IT. This article explicitly tests this assumption. Given the inherent differences in the fields of CS and MIS, students majoring in CS and MIS might differ from one another. These differences, coupled with the different academic atmospheres encountered in highly technical vs. business-oriented fields might present different challenges for women majoring in CS vs. MIS.

Previous research delineated several reasons for the small number of women in CS: Low computer self-efficacy, lack of programming and hands-on computer experience, negative stereotypes regarding the field, and lack of role models. Women have inaccurately low self-evaluations (i.e., their confidence is lower than warranted by their abilities) in domains traditionally considered masculine, including mathematics and chemistry (Beyer, 1999a, 2002), and CS (Beyer, 1999a; Beyer, DeKeuster, Walter, Colar, & Holcomb, 2005; Beyer, Rynes, Perrault, Hay, & Haller, 2003; Lips, 2004). Although women extensively use computers as tools, they have less programming experience than men (Beyer, DeKeuster, Rynes, & DeHeer, 2004; Beyer, Rynes, & Haller, 2004; Margolis & Fisher, 2001).

CS is stereotyped as very male-dominated and both men and women *incorrectly* believe that male CS majors have higher grade point averages (GPAs) than female CS majors (Beyer, 1999b). The stereotypes about individuals in computer-related fields are unflattering: CS majors are perceived as intelligent but interpersonally deficient (American Association of University Women, 2000; Beyer, Rynes, & Haller, 2004). This has been termed the "computer nerd syndrome", "geek mythology", or "hacker mentality" (Jepson & Perl, 2002; Margolis & Fisher, 2001). CS is also incorrectly perceived as involving only programming and no creativity (Craig, Fisher, Scollary, & Singh, 1998). The perceived obsession with machines and lack of interest in people, and associations of technology with masculinity conflict with women's interpersonal orientation, that is, their tendency to value careers with opportunities for social interaction and nurturance (Cross & Madson, 1997; Zahn-Waxler, 2000). This may deter women from majoring in CS. Unfortunately, we know little about the stereotypes about MIS students.

We have at least a rudimentary understanding of what deters women from taking CS classes (see also Lagesen, 2003; Margolis & Fisher, 2001). Departmental and classroom climates in CS affect the success of students (Margolis & Fisher, 2001). Social support, faculty encouragement, and the presence of role models are more important to women's than men's decision to enroll in or leave CS (Cuny, Aspray, Cohoon, & Jesse, 2003; Margolis & Fisher, 2001). Indeed, "female students in technical disciplines, perhaps partly because of their 'outsiderness,' are especially vulnerable to poor teaching, inhospitable teaching environments (such as large classes), and unhelpful faculty" (Margolis & Fisher, 2001, p. 83). For example, female engineering students with low self-evaluations who perceived the academic environment in their department to be supportive, experienced lower levels of stress and higher self-esteem one year later than women who perceived the department as less supportive (Cross, 2001). Again, we know little about MIS students.

METHOD

All participants were enrolled at the University of Wisconsin-Parkside, a public university with an undergraduate enrollment of approximately 5000 students. In the CS sample, 108 students participated (25 females, 83 males); in the MIS sample, 135 students participated (67 females, 68 males). To make comparisons between the two IT majors possible, I assessed constructs that were found to be important in previous research on CS and extended them to MIS. I measured students' computer experience and self-efficacy; stereotypes about CS or MIS; role models; and climate in the classroom and program. Furthermore, I collected students' ACT scores (an achievement test commonly administered in U.S. high schools) and college grades. More details on the measures and statistical tests can be found in various publications (Beyer & DeKeuster, in press; Beyer, DeKeuster, Rynes, & DeHeer, 2004; Beyer, Rynes, & Haller, 2004; Beyer et al., 2003, 2005).

RESULTS AND DISCUSSION

Table 1 presents the means of the variables discussed. Throughout I will point out similarities and differences in the results of the CS and MIS samples. To assess gender differences, analyses of variance, chi-squares, and regressions were calculated. All reported gender differences are statistically significant at the $p < .05$ level or better.

Mathematical Ability, Computer Experience, and Self-Efficacy

CS students had higher mathematics ACT scores than MIS students underscoring their greater mathematics aptitude. No gender differences were found in mathematical aptitude (ACT scores) or grades in students' major for CS or MIS students. Other researchers have also found no gender differences in the grades or standardized test scores of students in mathematics-intensive majors (Cross, 2001). Male CS and MIS students had more programming experience and more experience installing RAM in a computer than did their female counterparts.

To determine whether there was a gender difference in computer self-efficacy when controlling for mathematical ability, I regressed participants' computer self-efficacy on gender, mathematics ACT score, and the interaction. As can be seen in Figure 1, female CS majors had lower computer self-efficacy than male majors regardless of their ACT scores. The same was true for MIS majors. Thus, female CS and MIS majors' computer self-efficacy

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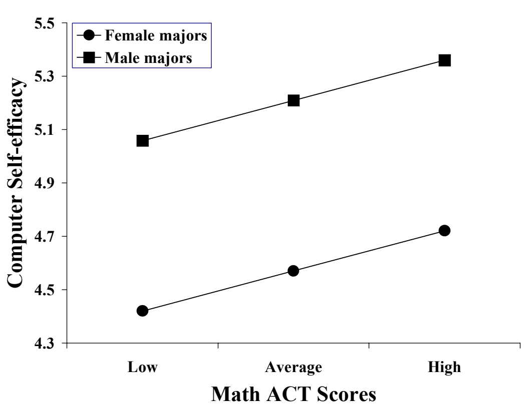
*Table 1. Means of variables discussed in text. * Scale ranges from 15 to 36; ** Scale ranges from 0 to 4; *** Scale ranges from 1 to 7*

	CS Majors		MIS majors	
Dependent Variables	Females	Males	Females	Males
Mathematics ACT scores*	25.3	23.9	21.9	21.3
GPA in CS/MIS classes**	2.8	2.8	3.2	3
Hours per week computer used for enjoyment	6.1	10.9	4.6	10.1
Installed RAM	50	82	32	74
Programming experience	81	94	77	93
Estimated weekly work hours of CS/MIS professionals	47.5	44.9	47.4	49.4
Age when first became interested in CS/MIS	20.8	15.8	N/A	N/A
Sex of computer teachers in high school***	4.4	4	4.8	3.4
Knew someone in CS/MIS	65	52	38	40
CS/MIS faculty are sensitive to students' needs***	4.7	4.9	5.2	4.4
The CS/MIS program atmosphere is impersonal ***	3.4	3.4	2.7	3.5
The CS/MIS faculty expect too much of students***	3.8	3.6	2.9	3.5
CS/MIS courses are too limited for my career goal	3.3	3	3.4	4.2
Faculty don't take female CS/MIS majors seriously ***	2.6	1.6	2.3	1.8
Ability of female CS/MIS majors is underrated ***	3.7	2.9	3.4	2.2

was lower than males', even when quantitative ability was statistically controlled. In fact, female CS majors with high mathematics ACT scores felt less self-efficacious than did male CS majors with low mathematics ACT scores.

Other researchers have found a similar gender difference in self-efficacy in undergraduates in mathematics-intensive majors (Cassidy & Eachus, 2002) and engineering graduate students (Cross, 2001). In fact, girls have lower computer self-efficacy than boys as early as fifth grade (Dickhäuser & Stiensmeier-Pelster, 2003). Computer self-efficacy is affected by the amount of previous experience with computers (Cassidy & Eachus, 2002). Indeed, female students in our study had less programming experience and less hands-on technical experience than male students did.

Figure 1. CS students' computer self-efficacy



Stereotypes about CS and MIS

There were few gender differences in stereotypes about CS or MIS. However, stereotypes of CS and MIS majors as "nerds" and their perceived lack of interest in people conflict more with women's greater interpersonal orientation (Cross & Madson, 1997), probably deterring women from majoring in CS or MIS.

Role Models

Female MIS majors had more female computer teachers in high school than male MIS majors did, a difference not found for CS students. These female computer teachers in high school may have served as role models for women, nurturing their interest in a computer-related field. A study of female engineering students in Germany also found that secondary school teachers had encouraged these young women (Blättel-Mink, 2002). Furthermore, a case study of female CS students in Germany found that positive experiences with computer teachers in secondary school cemented their interest in CS (Huber et al., 2001). However, in our sample of CS students, female students were not significantly more likely to indicate that their computer teachers in high school had been female.

Climate in the Classroom and Program

To set the following findings in perspective, at our institution the CS department's seven faculty includes three women; all of the four MIS faculty members are male. Despite having only male MIS faculty, female MIS majors had less negative perceptions of the climate in MIS classrooms and the program in general than did male MIS majors. For example, male compared to female MIS majors felt that the climate in the MIS program was more impersonal, that MIS faculty are less sensitive to the needs of MIS students, and that MIS faculty expect too much of MIS students. No gender differences for these variables were found for CS students.

Although on an absolute level students felt there was little discrimination against women, significant gender differences did emerge. For example, female compared to male CS and MIS majors felt that faculty in CS/MIS do not take female majors as seriously as male majors and that faculty underrate the ability of female CS and MIS majors.

Thus, for general questions about the climate in the CS/MIS programs and classrooms, no gender differences were found for CS majors and the gender differences for MIS majors were in the direction of greater male dissatisfaction. However, consistent gender differences in CS and MIS were found regarding students' perceptions of subtle forms of gender discrimination. Both female CS and MIS majors perceived there to be more gender discrimination than did their male counterparts, which may contribute to attrition among female CS and MIS students.

FUTURE TRENDS

Beyond the specific findings of this research, an important contribution of this study to the literature on women in IT is that it points out that generalizations from research on women in one IT area, such as CS, to a different area in IT, like MIS, are not always appropriate. Several findings did differ by IT discipline. Women majoring in CS are different in their aptitude, interest, and a host of psychological variables and face different challenges in their academic departments than women majoring in MIS. Thus, generalizations from research findings on women in CS to women in MIS or vice versa are inappropriate and may lead to erroneous conclusions. Future research on the underrepresentation of women in IT should carefully examine the differences in the various IT fields. To this end, comparable assessments of students in a greater variety of IT fields would prove valuable. Furthermore, it would be instructive to assess non-IT fields as a comparison group. This would yield valuable insights regarding the generality of findings where gender differences are consistent within IT fields. For example, in this study female CS and MIS majors perceived more gender discrimination than did males. Is this finding specific to IT, does it hold for all male-dominated majors, or possibly all majors?

CONCLUSION

Prior to offering conclusions, I point out limitations of this research. The relatively small number of female CS majors limits statistical power. This means that some real gender differences may not have been detected in our sample. In addition, the data were gathered at a small public university, possibly limiting generalizability to institutions of similar size.

This research examined a large number of variables that could adversely affect the number of women majoring in CS or MIS. Variables that might negatively impact women in CS or MIS include less programming experience, lower computer self-efficacy, fewer available role models, and subtle forms of gender discrimination in the classroom. Our findings suggest possible avenues for increasing the representation of women in CS and MIS.

Women in the CS and MIS samples had lower computer self-efficacy than their male counterparts, which may decrease the likelihood that they will choose to major in CS or MIS and may increase the likelihood that female CS or MIS majors will drop out of their major. This means that women miss the opportunity to enter into highly paid fields with

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excellent career potential. Therefore it is important that instructors help increase female CS and MIS students' computer self-efficacy. Encouragement and steering female students to activities that increase their practical skills such as internships or teaching or lab assistantships may accomplish this.

One potential explanation of women's lower computer self-efficacy is a lack of experience in programming. To increase the number of women in computer-related fields exposing them to computers may not be enough. Programming might be a crucial experience for all students interested in computer-related fields, but might be particularly important for women's computer self-efficacy. Because CS is the more technical field, female CS majors' lower computer self-efficacy is likely to have more serious repercussions than it does for female MIS majors.

Role models are important in getting women interested in MIS. Female MIS students had more female computer teachers in secondary education than did male students.

There were no gender differences in CS majors' perceptions of the general classroom climate and their program, whereas male MIS majors had consistently more negative perceptions than their female counterparts. In light of the fact that women's attitudes toward their classroom experiences and their program were either not different from men's or in fact more positive, it is especially interesting that women reported more subtle gender discrimination than their male counterparts perceived. To increase retention departments should carefully avoid creating any perception of gender discrimination. Departments that address self-efficacy and gender discrimination issues that are of concern to female students may be rewarded with increased retention and recruitment of female students.

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KEY TERMS

Computer Self-Efficacy: Refers to a person's confidence in his or her computer skills. Women have lower computer self-efficacy than men.

Inaccurate Self-Evaluations: Refer to a comparison between an individual's ability and his or her perception of ability in a specific area. Women's self-evaluations are inaccurately low for stereotypically masculine domains, such as CS.

Interpersonal Orientation: Refers to a person's orientation towards people as opposed to objects. Women score higher than men on interpersonal orientation. In their career aspirations they emphasize professions that allow them to help others, to nurture, and/or to have frequent social interactions with co-workers or clients. CS is typically perceived as a field that appeals to individuals who are low in interpersonal orientation.

Perceived Gender Discrimination: Refers to students' perceptions that their instructors display differential behaviors or attitudes toward female and male students.

Role Model: Is an individual who serves as a source of inspiration. Role models show others who are similar to them in demographic characteristics such as sex or race, or are similar in goals, abilities, aspirations, or personality that success in a certain area is possible. Role models may not be aware that they are performing this function and may not even know the individual(s) they are inspiring.

Stereotypes: Are individuals' beliefs about social groups. Stereotypes need not be negative, nor are they always inaccurate.

Stereotypes about CS: Include the "nerd" "geek" or "hacker" images of computer scientists. Computer scientists and CS students are often stereotyped as intelligent, particularly regarding quantitative skills, but single-minded in their interests, and interpersonally deficient.

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A Complex View of Technological Change in the UK

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INTRODUCTION

This article seeks to discuss women's ambivalent but potentially positive attitude to and relationship with new technologies, as exemplified by Internet and mobile technologies, using as an illustration the results of a UK-based qualitative study into women's perceptions of technological change. The research sought to investigate how individuals understand recent technological developments, analysing the data in the light of theoretical discussions of new technologies and the information society, as well as feminist analyses of gender and technology.

The spread of information and communication technologies has been rapid and significant. For instance, the number of UK households that are connected to the Internet has increased steeply from 9% in 1998 to 52% in 2004, while also in 2004, 37% of UK adults had not yet used the Internet. Meanwhile, individual ownership of cellular phones has increased swiftly to over 70% (Office for National Statistics, 2004). This implies a considerable range of experience and inexperience of new technologies amongst the general public currently. Government policy has also impacted the diffusion of ICT in the United Kingdom, as elsewhere. In particular, the development of the People's Network of Internet access points in public libraries throughout the United Kingdom has been a prominent strand in the government's information policy (Library and Information Commission [LIC], 1997), aiming to make new technologies widely available to the citizenry and requiring people working in this field to become Internet literate, with implications for library staff at all levels of employment. Indications are that the People's Network may be altering the library-user demographic, and that many people are experiencing the Internet for the first time via the public library ("Beardy-Weirdies' Rule," 2003).

These developments led to an interest in perceptions of technological change, particularly among those working in the library sector, as a site of government information policy. The focus of the research was women working in this field, but it was complemented by a further sample of women with little or no experience of new technologies. The intention behind this was to provide a rich variety of data whilst maintaining a focus on individuals who are less often the subject of research on new technologies. The study took an interpretive perspective, utilising in-depth, semistructured interviews with 50 women as described above during the period of 2001 to 2002, and using grounded theory to analyse the resulting data. This approach favours the development of concepts that are rooted in the data, useful for an exploratory project, which can be subsequently compared to and placed in the context of existing literature and theory. An overview of the central theoretical contexts of the project is presented below followed by a discussion of the results and their wider relevance.

BACKGROUND

Women have long been dominant in the library field, accounting for upwards of 70% of the employees in the UK and U.S. library sectors (Harris, 1999), and they have been the focus of some research in this respect, particularly in the field of information studies, from which this project originates. Underrepresented at the higher end of the salary scale, their dominance at the lower or nonprofessional end is marked. It has been argued that the predominance of women in a profession may negatively impact its status (Harris, 1992). In fact, gender relations are becoming increasingly important in the library sphere, as this traditionally "female-intensive" profession becomes a "technologically dense site," and as yet, insufficient attention has been paid to this issue (Dilevko & Harris, 1997, p. 719). Technological change may de-skill women or downgrade their traditional roles in the library sphere, although Harris also points out an often-positive attitude to such change in the workplace (1992, 1999). Of course, women have been using technology in libraries long before the advent of the Internet, and are understood to have been "intensive systems users" throughout the 1980s (Green, Owen, & Pain, 1993, p. 132). A more recent development, however, as noted above, is the way that government policy, in the United Kingdom at least, seeks to engage library workers at all levels with new technologies.

The broad framework for the research was the concept of the information society and discussions of social and technological change within this context. There is an ever-growing body of work on the information or network society, for example, Castells' (2000) key study of the information age. Within the field of information studies, literature focuses on the role of the information worker or information policy in the United Kingdom, as well as wider analyses of technological change (Dearnley & Feather, 2001; Feather, 2002). Some authors take a critical perspective toward the concept of the information society itself or the hyperbole that seems to attach to it, and to the technological developments that are understood to underpin it (Garnham, 2000; Golding, 2000; Robins & Webster, 1999; Webster, 2002).

Clearly, then, there are many examples of theoretical analyses of the information society and new ICT. In recent years, there has also been a welcome increase in the number of empirical studies that investigate the role, use, and place of the new technologies such as the Internet in everyday life, helping us to ground our understanding more firmly in the context of individuals' lived experience (Wellman & Haythornthwaite, 2002; Woolgar, 2002). It is this developing understanding to which it is hoped the current article contributes.

An important perspective also comes from feminist analyses of women and technology, particularly gender and technology studies that theorise the social construction and gendering of technologies (Adam, 1998; Cockburn, 1994; Faulkner, 2001; Grint & Gill, 1995; Kirkup, 1992; Wajcman, 2000). In terms of empirical research, much literature attests to the differences in experience of and attitudes toward computers between men and women, although many studies also acknowledge other cultural factors involved. It has been argued that as the Internet becomes pervasive, women's attitudes to it become increasingly important. It is less and less a matter of "take it or leave it" as it becomes harder to avoid engaging with ICT, therefore it becomes ever more vital to understand how women think about and deal with technology in their everyday lives (Li, Kirkup, & Hodgson, 2001).

EXPERIENCE AND PERCEPTIONS OF ICT

Many of the women interviewed for this project expressed very positive attitudes toward new technologies, or at least some aspect of them (the Internet, cell phones), which may be understood as an encouraging sign for women's future relationship with ICT and the information society. This was especially evident among library staff that had some regular access to the Internet at work. However, it was by no means a universal or consistent expression, and many sceptical or critical points of view were also articulated. Most commonly evident was a sense of ambivalence toward new technologies and their apparent social implications. It is helpful to think in terms of a shifting continuum of attitudes, ranging from the dismissive and highly sceptical to the positive and enthusiastic. Most points of view existed somewhere between these points and were flexibly dependent upon the type of technology being discussed, its location, and mode of use. Ambivalence is articulated in particular ways in the women's talk, as described below. The concept is examined here in terms of how it is apparent in the data and how seemingly contradictory attitudes are reconciled, or at least enabled to coexist, as individual women make sense of and integrate social and technological change into their everyday lives.

Many women, particularly those who regularly used new technologies such as the Internet, reported positive or empowering experiences. This ranged from simply overcoming their doubt and suspicion of a new technology, to being regular, enthusiastic users, making use of various ICT in many aspects of their lives. Participants often described feelings of reluctance or scepticism before having their first contact with ICT: Subsequently, they felt much more positive or at least comfortable with new technologies. Enjoyable and confidence-building experiences were often described, allowing women to help both themselves and others. Many women had a story about learning something new, making or renewing a contact, accessing information for themselves, which made them feel more in control, or successfully making a purchase online for the first time.

From this perspective, it is possible to envisage the Internet as a site for women's leisure and pleasure without resorting to perhaps more unfounded "cyberfeminist" proclamations about the liberating nature of new technologies (critiqued by Adam, 1997). It can be understood, rather, in terms of an ambivalent but pragmatic approach to new technologies that is grounded in individuals' everyday experience.

For many of those interviewed, their knowledge of the Internet had been gained or developed in a work context; for example, those women who worked in the library profession had, or were currently undergoing, various forms of ICT training. The location of ICT use, for instance, the workplace, appeared to be a factor in how at ease the women felt with it. In the library work environment, women may be able to experience a level of access to ICT that might not be available to them within the domestic sphere. Because an emphasis has been placed on their professional development, now including computer proficiency, being a skilled Internet user is a key part of the information worker's portfolio of skills: According to one participant, "You have this barrier—we've had to overcome it at work, but at home you don't have to unless you want to."

Of course many people have Internet access at home, but as some commentators have noted, we have as yet very little information about how computers are placed in the domestic sphere and how their use is negotiated. The home, for women, is traditionally not a clear-cut site for leisure, which may be interrupted or fragmented by various household tasks (Green, 2001). Indeed, some women explicitly stated that they used the Internet, including for personal use, at work rather than at home for a variety of reasons: being able to find the time, a better connection speed, and not having their children and/or spouse (usually the former) taking up time on or having responsibility for the computer.

QUESTIONING THE VALUE OF NEW TECHNOLOGIES

Doubtful or ambiguous attitudes were also clearly evident, and ambivalence emerges as a dominant theme. Some women would clearly state their uncertainty: "The Internet's a funny thing, I kind of feel. I kind of feel it's great and I also kind of feel it's quite dangerous."

In other cases, ambivalence would become apparent in the course of the discussion. For instance, some women expressed a fear of being left behind if they did not keep up with new technologies. This was compounded by the perception that certain factors served to exclude those individuals that did not or could not access the Internet, for example. Reference was made, for instance, to the assumptions that appeared to be made in schools that a child had access to the Internet outside the classroom (e.g., in setting homework), or to the way in which the established media seem to assume connection, and how they emphasise a lack of access by constant reference to Web sites, for example, in advertisements or at the end of television programmes. This may serve to construct individuals as outside the network age and also creates the feeling of imperativeness to be online.

On the whole, negative or doubtful attitudes came from those who had less, or no, actual experience of ICT, although it is more complex than simply thinking in terms of a user-nonuser binary. Some nonusers expressed simple disinterest in ICT (which may of course mask a deeper anxiety), while more experienced users resisted certain aspects of new technologies or used the rhetoric of resistance or scepticism when discussing them. Although it is articulated in varying ways, such ambivalence appears to range across levels of experience and educational background. It may be expressed in terms of different attitudes toward difference aspects of ICT, different attitudes toward the same technology depending on context, or different opinions at various points within a dialogue. Rather than assessing this as a contradiction, we can instead understand it as part of a process of making sense of change, which is revealed in these conflicting yet coexisting perceptions. This was manifest in tensions that appeared within a dialogue, and also in self-conscious discussion of positive and negative aspects of ICT. What were deemed to be appropriate and inappropriate uses of specific technologies were also highlighted.

To provide an example, mobile (cellular) phones were often a topic of discussion in this respect. This aspect of new technologies attracted very strong feelings. The tensions apparent here were between an understanding of mobile phones as useful or even indispensable, and many expressions of annoyance or exasperation at what was deemed unnecessary or thoughtless use, for example, loud conversations on public transport, people using them while driving, or an audience member taking a call during a school play. Others talked about peer pressure or selling their soul as part of the process of acquiring a mobile phone while also acknowledging their dependence on it. There appears to be a fast level of adjustment to change, with participants being highly conscious of their change in attitude. Similar observations were made in relation to the Internet:

... I think it's ... merged into the background as it were. It's not mentioned per se, it's not mentioned as "ooh you can now do this, and you can now do that," you know. It's just accepted I think ... part of everyday life.

The comparison of new technologies with other earlier technological innovations was a tool often employed to articulate the process of technological evolution and to describe personal adaptation to change:

All these things, we when first got a video [VCR]—we all started off, obviously, in families where we didn't have any of those things. You start off thinking you don't need it, then you get one and you find 'oh yeah, it is quite useful' ... It's been exactly the same with each new thing.

It has been argued that ambivalence toward ICT (in Western societies at least) may promote a process of appropriation in order to "de-alienate" and familiarise particular technologies (Lupton & Noble, 2002, p. 20). Other methods of de-alienation may apply too, such as comparing new technologies to established ones (the telephone, television, radio) and locating them in this context in terms of other societal changes.

FUTURE TRENDS

There appears to be rapid adaptation to change and an integration of new technologies into women's everyday lives. As such, it is argued here that ambivalent or contradictory attitudes are integrated, or made sense of, by individuals seeing ICT both as positive and negative rather than either-or. This is a very fluid position: Women are finding their place in the information age, accepting parts of it, and rejecting or regarding with suspicion others.

Henfridsson (2000) discusses the diverse interpretations that attach to a new and unknown technology in the workplace, but which solidify over time and use into more consistent meanings. We might think along these lines in a wider social sense: The implications of new technologies are as yet unclear, and not only to those actively involved in researching the field. The scope for interpretive ambivalence is thus wide, perhaps more so amongst those with limited experience, and allows for a variety of sense-making processes. Many positive experiences and perceptions were highlighted in the research, but this was tempered by more critical attitudes, often within the course of a single dialogue. These appear to coexist rather than cancel each other out, and may find support in understandings of ambivalence as a more realistic representation of women's experience of technology (Faulkner, 2001) and, as such, a more practical way forward in analyses of gender and technology.

Due to the rapidly developing nature of new technologies and the various stages of this expansion in different cultures, this study inevitably represents a case study or snapshot of the situation in the United Kingdom. Longitudinal methodologies would seem to lend themselves to studies of perceptions and acceptance of technology, and it is intended that the author will pursue such an approach in order to develop the concepts outlined here.

CONCLUSION

It is evident that women enjoy new technologies and gain confidence from using them, however, their interest or need to be online should not be assumed. What is important is to understand the agency of the individual, and the variety of women's interpretations that are grounded in both gender and experience of technologies, but also in the social complexity that is the context of their lives.

This is not to say that ambivalence does not reflect genuine issues of concern, for example, the fact that the low numbers of women entering the computing and IT industries remains problematic, and that this takes place within the context of social constructions of technology and gender that may impact what technology is available to them, where it is available, and how their roles in relation to it are defined. But the agency of those interviewed, in terms of attitudes and understandings as well as action, is also apparent. The participants of this research are thinking critically about technological and social change, and this is reflected in the complexity and variety inherent in the interview data.

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KEY TERMS

Information Policy: An umbrella term referring to government policy in relation to information, ICT, or the development of the information society.

Information Professional: A qualified person (usually with a degree) working in the field of librarianship or information management, including libraries, information centres, and records offices.

Information Society: A widely debated concept that foregrounds information and especially ICT in the developing social structure.

Information Studies: A broad academic discipline covering all aspects of the library and information profession—both the practical and theoretical.

Information Worker: Libraries employ both professional and nonqualified staff, although the boundaries between them in terms of roles and status are often blurred.

People's Network: A network of Internet connections in public libraries across the United Kingdom established with government funding (1997-2002).

Computer Skills, Technostress, and Gender in Higher Education

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INTRODUCTION

The creation of computer software and hardware, telecommunications, databases, and the Internet has affected society as a whole, and particularly higher education by giving people new productivity options and changing the way they work (Hulbert, 1998). In the so-called "information age" the increasing use of technology has become the driving force in the way people work, learn, and play (Drake, 2000). As this force evolves, the people using technology change also (Nelson, 1990).

Adapting to technology is not simple. Some people tend to embrace change while others resist change (Wolski & Jackson, 1999). Before making a decision on whether to embrace technology or not, people may look at the practical and social consequences of accepting change. Therefore, the technology acceptance model, the accepting or resisting of technology is considered to be a form of reasoned behavior (Wolski & Jackson, 1999).

BACKGROUND

Technology changes the way people work and learn. As the role of technology is being defined and technology is constantly being improved, change is inevitable (Brand, 2000; Davis-Millis, 1998). As a result, those involved in higher education have to find ways to adapt to technological change. Administrators, faculty, academic librarians, and students should define the role of technology for the purposes of (1) sharing new ideas and techniques for teaching and learning; (2) encouraging enthusiasm and innovativeness; and (3) learning about opportunities and challenges, and how to deal with them (Landsberger, 2001).

In fact, college faculty are spending more time with those from the business sector to ensure what is taught in the classroom is applicable in the workforce (Gavert, 1983; Katz, 1999; Lynton, 1984). This partnership is providing opportunities for faculty to remain current in rapidly changing technical disciplines because both are collaborating on curriculum that meet education standards and job related skills required in industry (Gavert, 1983; Katz, 1999). And the researcher presumes that professors in Colleges of Business Administration are more adept and comfortable using technology than those in other colleges within universities. On the other hand, other disciplines such as liberal arts have had less need to adapt as quickly, and perhaps have been more reluctant to change (Miller & Rojewski, 1992).

Likewise, education faculty are preparing future teachers, counselors, and administrators to go into elementary, middle, and secondary schools. These teacher programs may or may not require their students to obtain and use technological skills. Similarly, there may or may not be an expectation among the education faculty to obtain or utilize these same skills. Some education faculty and students may only learn and use technology because they wanted to and not because there was an expectation (Miller & Rojewski, 1992).

University library staff also has had to adapt to a wide variety of technological demands unimaginable just a few years ago (e.g., processing library materials and teaching research skills online). Other disciplines such as liberal arts have had less need to adapt as quickly, and perhaps have been more reluctant to change. All, however, are faced with the necessity to change. Therefore, in all likelihood, all faculty and librarians are experiencing some level of technological stress.

Furthermore, the rapid growth in technology over the last three decades has been well documented. Accompanying that growth has been an equally rapid increase in the struggle to keep up with technology. The way services are provided by society and to society (e.g., fast, instantly, remotely) is changing. While virtually all facets of society are affected by technology, its impact can be clearly seen in the way higher education clientele have been served. Colleges and universities are being changed in multiple and profound ways, ways almost unrecognizable to students, faculty, academic librarians, administrators, and alumni.

The move to the Information Age, with its changes and need for adaptation to technology, has been rapid and stressful for many people. While many people have increased their technology use and are comfortable with it, many others still do not use much technology and are not comfortable using it when they must do so. For those who are not amenable to change, who find it difficult to adapt, there are often a variety of responses or results. One such response is called technostress. Technostress is the inability to adapt to or cope with new computer technologies which reveals itself in one of two ways: (1) computer users struggle to accept the technologies or (2) computer users over-identify with the technology (Brod, 1984).

Studies relating to technostress have been fairly limited. Those conducted have sought to determine correlations between such variables as personality type, academic performance, self-concept, and why certain faculty decided to use technology while others do not. Study participants have included people from the business industry, students majoring in business and education, and a limited number of faculty members and librarians. However, there are few studies that look at the severity of stress for various types of computer users (e.g., faculty, academic librarians) in postsecondary settings based on the computer users' gender.

For example, differences between females and males regardless of discipline were identified in the way they accepted or resisted technology. Even though Sievert, Albritton, Roper, and Clayton (1988) and Ballance and Ballance (1992, 1993) found computer-related stress was not related to computer experience and sex, other researchers found a relationship. For instance, females experienced technostress or resisted information technology (IT) more than males (Fine, 1979; Elder, Gardner, & Ruth, 1987; Hudiburg, Brown, & Jones, 1993; Ogan & Chung, 2003). Additionally, Heinssen, Glass, & Knight (1987) believed the less computer experience a female had the more computer anxiety she experienced. Murphy, Coover, and Owen (1989) revealed men were better able to perform certain computer skills more successfully than females. Similarly, Reed and Overbaugh (1993) found men to have less computer anxiety as their computer experience increased. According to Baroudi and Levine (1997), "women were generally more scared of computers ..." (p. 178). Finally, females rated information technology as the fourth cause of stress while men rated IT as the fifth cause of stress (Sax, Alexander, Korn, & Gilmartin, 1999).

Male and female faculty members and librarians also identified the IT they used as well as certain coping skills to help them handle the increased stress. The information technology identified included e-mail, spreadsheets, the Internet, statistical software, presentation software, and multimedia software (Groves & Zemel, 2000) where e-mail, spreadsheets, and the Internet were highly used. They suggested eating, relaxing, staying healthy, having a positive attitude, managing time, setting realistic goals, and seeking additional training as ways to cope with their stress as they continued to use information technology (Hickey, 1992; Kupersmith, 1992; McKenzie, Davidson, Bennett, & Clay, 1997).

With this, the intent of the current study was to explore the relationship between technology skills and the possible causes of technostress among academic librarians, and education and business faculty. The exploration looked at the role, if any, of how gender may have also made a difference in this relationship between technology skills and technostress.

FUTURE TRENDS

Research Method

This study was originally designed to answer the following question based on several demographics: Do computer skills relate to the levels of technostress among faculty in the Colleges of Business and Education, and academic librarians? However, the main focus of this article is on the gender of faculty in the Colleges of Business and Education, and academic librarians and the relationship between their computer skills and levels of technostress. As a result, 994 eligible participants were identified and 316 usable surveys were returned (32.8% return rate).

Participants were given the option of completing a survey instrument electronically and having the responses e-mailed to the researcher (n=234), or receiving numbered, color-coded paper copies, and mailing the results back to the researcher in a self-addressed stamped envelope (n=93). The numbered, color-coded paper copies were used to keep track of participants who responded so the researcher could do follow-up requests for survey participation. The survey was a new instrument containing four sections: (1) Computer Hassle Scale-revised (CHS-R); (Hudiburg, 1999) (2) Computer Skills Survey (May, 1998); (3) two open-ended questions; and (4) demographic items. When completing the CHS-R section of the instrument, respondents were asked to circle the number corresponding to the severity of the computer hassle they have experienced. Choice of numbers were 0=not at all, 1=rarely severe, 2=moderately severely, and 3=extremely severe. They were asked to complete the Computer Skills section by rating his/her skill level. Answer choices were 1=low, 2, 3=medium, 4, and 5=high. The faculty and academic librarians were then asked to answer two open-ended questions about what they perceived to be possible causes of technostress and possible solutions for relieving technostress. Lastly, faculty and academic librarians were asked to provide certain demographics including gender.

Alternatively, participants completed the instrument electronically by filling out a Web-based form posted on the Internet. Using the same numeric code found on the paper copy of the survey, each faculty member or academic librarian wishing to complete the instrument online was able to enter that code on the Web form for tracking purposes. The code was used to keep track of those who responded to the survey so the researcher could request participation from non-respondents after follow-up contact had been made with those not responding initially. Each participant completed the CHS-R section by clicking the radio button corresponding to the appropriate severity level of each of the computer hassles they have experienced. The choices were the same as the ones on the paper copy. Similarly, the Computer Skills section had clickable radio buttons corresponding to the skill level for each computer skill. The choices were the same as those on the paper copy. Two open text boxes were provided for respondents to type in their responses to the open-ended questions. Lastly, clickable radio buttons were provided for responding to the demographics section. All responses from the survey were snail mailed or e-mailed to the researcher for data analysis.

Research Findings

The major findings of the current study were:

1. Male and female business faculty reported their computer skills as the highest over education faculty and academic librarians (see Table 1).
2. Male and female academic librarians perceived themselves to experience more severe levels of technostress than male and female business and education faculty (see Table 1).
3. Male academic librarians reported the lowest computer skills level, while female academic librarians perceived to experience higher levels of technostress (see Table 1).
4. All males reported lower computer skill levels and they perceived to experience more severe levels of technostress (see Table 2).
5. The levels of technostress among males and females regardless of discipline decreased as their levels of computer skills increased (see Table 2).
6. Academic librarians, education and business faculty regardless of gender used a wide va-

Table 1. Computer skills and technostress levels by gender of COBA, COE faculty, and academic librarians

	Computer Skills					
	Males			Females		
	M	SD	n	M	SD	n
COBA	3.88	.73	51	3.97	.76	30
COE	3.58	.92	69	3.74	.78	66
LIB	3.46	.84	11	3.57	.70	29
	Technostress Levels					
	Males			Females		
	M	SD	n	M	SD	n
COBA	41.43	19.73	51	43.27	19.95	30
COE	45.17	20.76	69	41.52	20.04	66
LIB	45.91	15.80	11	47.10	21.29	29

Table 2. Correlations between computer skills and technostress levels of males and females

	r	p*	n	Computer Skills	Technostress
Males	-.29	.00	155	3.67	43.34
Females	-.32	.00	161	3.74	42.67

*Significance is p≤0.05

Table 3. Ordered rank of applications used by COBA, COE faculty, and academic librarians

1. E-mail
2. Word Processing
3. Internet
4. Presentation
5. Library Databases
6. Spreadsheets
7. Library Catalog
8. Databases

Table 4. Technostress causes as perceived by COBA, COE faculty, and academic librarians

Cause	Frequency
computer information problems • difficulty keeping up, too many passwords	178
computer runtime problems • hardware failure, computer crashes	119
computers' impact on society • increase in expectation to use computers, increase in demand or time to use computers	70
Internet/E-mail problems • too much e-mail, spam	48
everyday computer technology • confusing, threatening computer terminology, answer cannot be found	42
computer processing speed • slow CPU/Internet connection	41
computer as person • lack of human interaction	8
computer costs • software costs	2

Note: Hudiburg (1997) identified eight categories for measuring causes of technostress

riety of software applications or other computer technology but they mainly used e-mail, word processing, and the Internet (see Table 3).

7. Participants identified computer information and computer runtime problems more than any other problem as causes of their technostress (see Table 4).
8. Solutions for reducing technostress as reported by the participants included calling for help, screaming or yelling, walking away, leisurely talking to someone, and doing something non-technical or non-computer related (see Table 5).

Findings-Past and Present

According to Fine (1979), Elder, Gardner, and Ruth (1987), Hudiburg and Jones (1993), Heinssen, Glass, and Knight (1987), and Ogan and Chung (2000), females experienced more technostress and resisted technology more than males which contradicts the findings of this study. However, the current study's results supported those revealed in Reed and Overbaugh's (1993) study that men had less computer anxiety as their computer experience increased. Additionally, faculty and librarians identified word

Table 5. Coping solutions as perceived by COBA, COE faculty, and academic librarians

Solution	Frequency
increase knowledge and skills • ask for help, attend training workshops	114
relax or socialize • take nap, talk to people	77
manage time or projects/tasks • multi-task, back up data	77
complain • threaten computer, yell and curse	54
try to fix the problem • reboot computer, start project over	29
exercise • yoga, play basketball	24
change attitude/expectations • find humor in situation, control anger	24
eat • drink tea, eat popcorn/candy	12
perform non-technology related tasks • clean office	1

processing, spreadsheets, and e-mail as highly used information technology (Groves & Zemel, 2000) while e-mail, word processing, and the Internet were identified in the current study. In summary, further research may be needed to understand how gender may relate to computer users' technostress levels and their computer skills. Furthermore, researchers could investigate the roles males and females play in the decision making process of technology implementation and training, the increased expectation to use technology in classrooms, and the increased expectation to use technology for tenure and promotion.

CONCLUSION

This study attempted to investigate whether computer skills relate to the levels of technostress among male and female faculty members in the Colleges of Business and Education, and academic librarians. The analysis of the data revealed a negative relationship that as computer skills increased, technostress levels decreased among males and females. However, further study may be necessary to determine and understand more the relationship of computer skills and technostress among males and females. Moreover, in order for computer users to experience less stress, they will have to keep up with the rapid change of technology and take part in some form of training on a regular basis. "Changes break patterns that we are comfortable to, and that can be rather threatening. The key is to make sure that we are the masters, and that computer and other formats of technology are tools we manipulate. IN SHORT, WE ARE THE ONES WHO ARE IN CHARGE!" (Rocha, 2001).

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KEY TERMS

Academic Librarian (LIB): Person who has completed an outlined course of study from an accredited library school and performs one or more of the following: (1) purchase and catalog resources for public use; (2) help find information for search or study; (3) plan, operate, and maintain computer systems; and (4) manage and plan library operations; and may or may not hold faculty status.

Business Faculty (COBA): Professor/instructor who teaches business courses at a college or university.

Computer Technology (aka Technology or Information Technology): Machines with cd-rom, DVD, zip, and/or floppy disk drives with software applications which are used to enhance human efficiency and workflow.

Education Faculty (COE): Professor/instructor who teach education courses at a college or university.

Information Age: Creation of computer software and hardware, telecommunications, databases, and the Internet.

Information Problems (aka Computer Information Problems): Having little or no information or sometimes having too much information when trying to utilize computer technology.

Over-Identification with Technology: Constant use of technology or over reliance on a computer to complete a task especially if the task is simple and may be performed by an individual much faster than performing the task by computer.

Post-Secondary Settings: Any college or university that prepares a person for a career beyond high school at the undergraduate and/or graduate level.

Runtime Problems: Difficulties occurring while software applications are being used.

Technostress: Modern disease of adaptation caused by an inability to cope with computer technologies in a healthy manner and manifests itself in one of two ways: (1) struggle to accept computer technology and (2) over identification with computer technology.

C

Computing in a New Zealand Urban Community

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INTRODUCTION

Governments and international organisations have expressed concern regarding what has been labeled the digital divide, that is, the gap between those people who have access to, and the ability to use, modern information technologies—such as computers, the Internet, e-mail, and other mobile technologies, often referred to as information communication technologies (ICTs)—and those who do not. As a result a range of measures have been put in place by public agencies in an attempt to reduce the inequities between the "haves" and the "have nots". One strategy which has commonly been used is the establishment of free and easy access to computing and Internet facilities within communities identified as needing such assistance.

In Wellington, New Zealand, a project called Smart Newtown has been implemented whereby free public access to computers and the Internet and free introductory classes are made available to all citizens. The researchers were employed to evaluate the implementation and sustainability of this project and this chapter discusses how, over a period of three years, the participation of women has changed. The questions asked were "How did the women benefit from their attendance?" and "What caused this change in participation?"

The article begins with a brief background on gender and ICTs, followed by a short review of the literature regarding the digital divide and community computing. One of the successful computing centers in the Smart Newtown project is then examined from a gender viewpoint.

BACKGROUND

While the term ICT does not exclusively refer to the Internet and its applications, but to other modern technologies, applications and services used to organize, transform, and transmit information (Marcelle, 2000), the Internet remains the main focus. From its inception, the Internet has been dominated by male "geeks", but when the World Wide Web became accessible to the general public, much was made of its potential to reshape and reorganize our work and "enhance the quality of human life" (Huyer & Sikoska, 2003, p. 1). It soon became clear that gender inequalities of access to, and understanding of, the Internet and its potential benefits continued, and Spender (1995) in her seminal book "Nattering on the Net: Women, power, and cyberspace" highlighted some of the specific inequalities which were becoming evident.

The first phase of the World Summit on the Information Society held in Geneva in 2003 raised gender-equality awareness by insisting on the critical relevance of gender to ICTs. This was timely as the adoption of ICTs has become internationally widespread amongst both developed and developing countries and it is of concern that many women are still not participating in the emerging information society (UNDP/UNIFEM, 2004). This is despite the programs that have been put in place by many governments, the United Nations, and international organizations to encourage adoption and use of ICTs as a means of helping reduce poverty and promote sustainable human development.

In New Zealand, groups identified as being likely to be excluded from the digital society include Maori and Pacific peoples, those on low incomes, solo parents (usually women), people with no or low qualifications or poor literacy, the unemployed, people with disabilities and people living in rural areas that lack a sound telecommunications structure (Community Employment Group, 2002). The consequences of exclusion from the digital era is noted in a recent report (The Economist, 2005, p. 11) where "the real digital divide" is defined as "but a symptom of deeper, more important divides: of income, development and literacy."

THE DIGITAL DIVIDE

Early definitions for the term digital divide, believed to be a "simplifying metaphor" by van Dijk and Hacker (2003, p. 322), refer to the gap that exists between those who have and those who do not have access to these modern technologies. The focus was initially on access and adoption rates to the technologies by different sectors of society within the developed world. DiMaggio, Hargittai, Neuman, and Robinson (2001) described the digital divide as being the inequality in access to the Internet including the degree to which it is used, knowledge of how to extract and evaluate information, and the variety of uses to which it is put. Others define it more broadly as the difference between those people who do or do not have access to technologies such as telephone, television, or Internet (Gurstein, 2003).

Gender, race, and class are factors, highlighted in many studies, where inequity of access exists. Often women have less money than men and this can prevent them purchasing the equipment necessary to gain access and training (Wylie, 1995). Two of the most critical issues regarding the 'gender digital divide' relate to access and control, and education, training and skill development (UNDP/UNIFEM, 2004) and it is in these areas where community ICT initiatives can play a pivotal role.

COMMUNITY COMPUTING

Community ICT projects with the objectives of increasing social capital and reducing the digital divide are recognized as being complex and often fail to meet these goals. Warschauer (2002) believes ICTs must have a social inclusion focus. He suggests a model that involves access to physical artifacts (computers and telecommunications), relevant content, human resources and skills, and social support in the form of community, institutional and societal structures that help access to ICTs. Warschauer considers these four sets of resources have an iterative relation with ICT use. The combining of all four sets of resources contributes to successful and efficient use of ICTs and, once effectively used, feed into promotion and extension of the resources.

Pinkett and O'Bryant (2003) take an "asset-based" view to community development and recommend leveraging the resources within a community by "mapping" these assets and then "mobilizing" them to "facilitate productive and meaningful connections" (p. 192). Asset-based community development uses existing resources (assets) within the community (thus being internally focused) and encourages the ongoing establishment of productive relationships among community members. Users are empowered through technology supporting their interests and become active producers, not consumers where the emphasis is on outcomes instead of access.

The approaches to community ICT taken by Warschauer (2002) and Pinkett and O'Bryant (2003) are underpinned by the principle that ICTs should be useful, effective, meaningful, and relevant. These theorists agree the end result should be user-focused.

The usefulness and relevance of ICTs is especially important for women in the early adoption stages of ICTs. Females need to perceive computers as a "tool to use within a broader context" (Fisher, Margolis, & Miller 1997, p. 4). The provision of a non-threatening, culturally suitable environment where women are able to learn how to use the technologies, with encouraging assistance is therefore vital. The next section presents an example of how a community ICT initiative has increased the participation of women and contributed to social capital through education, training, and skill development.

THE PROJECT

New Zealand has been a rapid adopter of new technologies. However, it was not until 2002 that the government committed itself to its first strategy to support community access to ICTs in an effort to close the digital divide (Community Employment Group, 2002). This strategy has given rise to a number of initiatives that are often supported by local or regional government, along with business and community organizations. One of these initiatives is the Smart Newtown Project, established in Newtown, an inner-city suburb of New Zealand's capital city, Wellington. The broad goals of the project are to assist disadvantaged groups to develop ICT skills essential for daily life, strengthen intra-family relationships, extend social networks, widen education and employment opportunities, and improve their future contribution to the economy. This section describes the Pacific Island Network Centre (PINC) and how the community ICT initiative has helped women, particularly immigrant women, achieve these goals.

The suburb of Newtown was selected because of its low socio-economic community. For at least five decades a significant proportion of its population have been new immigrants; initially Pacific Islanders, Indians, and Chinese. More recently, the immigrant community has diversified but has largely been comprised of people from war zones such as Somalia and Iraq, many of whom are refugees. When immigrants arrive from such countries they are faced with significant barriers including language acquisition, cultural differences, economic problems and, for those women who are unable to work, isolation due to lack of access to social networks and separation from their families. There is also a large population of solo parents, unemployed and other socially underprivileged groups in Newtown.

Eleven networked computers were installed at PINC in 2002. Members of the public have free access to the computers and the Internet and free classes are available in basic applications such as word processing, spreadsheets, Internet searching and e-mail. These classes are offered in modules covering introductory, beginner and intermediate grades and consist of two two-hour sessions per week over four weeks. The computing coordinator, an immigrant from India, is responsible for teaching the classes, maintaining the computers, and coordinating volunteers. The center is open weekdays from 10 am-5 pm.

PINC has many of the precursors for success as a community computing centre—it is a non-threatening, community owned and operated public space (see Liff & Steward, 2001). It has also successfully leveraged off existing resources and augmented them with technology to create a successful new community resource—a necessary criteria for success identified by Pinkett and O'Bryant (2003). In the three years since the computers were installed there has been a noticeable increase in the number of females using the center and enrolling in the classes.

Results

Computer user statistics regarding casual usage and enrolment in classes have been gathered over the three-year period. As well, formal interviews and casual conversations with a variety of stakeholders have been conducted and regular observations of the room undertaken by the researchers. The qualitative data support the user statistics.

In the first year the majority of participants, both casual users and those enrolled in the classes, were Indian males. Many of these users reported that their reasons for coming to the centre were to access the Internet to look for work or to gain skills which would lead to better work opportunities. By 2004, 25 different ethnicities were using the centre, and from June 2003 until the end of 2004, female participation in classes consistently outnumbered those for males. In fact, for five of 10 months in 2004, there were at least 50% more females than males, a significant percentage being new immigrants. There was also an increase in husbands and wives attending classes together, thus reinforcing intra-family relationships.

Another interesting change has been that women are now consistently using the Internet and email more than men. In one case, an Iraqi woman brought her mother to classes so she could learn to use the Internet and email in order to access the Iraqi news and have contact with family members residing in other countries. Another was able to receive digital photographs of her baby nephew, print them, and take them home to her family. This ability to communicate with family, and maintain timely links with their home country, was very important to the immigrant women.

A further important aspect was the forging of friendships through attendance at classes. PINC provides a supportive and welcoming environment for users, with a very helpful coordinator and volunteers on hand. This is especially encouraging for those who are lacking in confidence or unsettled and homesick, as many immigrants and refugees may be. The PINC computing environment has many of the characteristics of a "third place" (Oldenburg, 1991). It is a welcoming, comfortable, socially inclusive setting where people can come and go at will, has frequency of regulars and good accessibility and visibility. Users encourage, support, and help each other—a collaborative approach to learning that appeals to many women.

PINC also provides a number of software programs that facilitate ICT adoption such as the Equal Skills package which is an animated computer familiarization course that also provides an introduction to the Internet. Learning is facilitated by a skilled tutor guiding the onscreen instruction. The blended learning environment is of special importance because many of the participants are from developing countries and have very limited English ability (Crump, 2004).

The immigrants who come to PINC to learn English have recently enjoyed the opportunity of having their language instruction combined with learning computer skills. Students are introduced to the Internet and shown how to access and use English language sites as well as how to access sites from their home countries. This has the additional benefit of helping new immigrants feel less isolated and can assist their adjustment to the new country. Of the 17 students in the first intake of this combined class, 12 were women. Again, this illustrates the value of a blended learning environment.

The success of the participants' new ICT skills' acquisition is celebrated on a regular basis. There is a communal morning tea where people contribute a plate of food and a prize giving at which certificates of achievement are awarded for completion of the computing modules.

These examples illustrate how the PINC computing center has developed a repertoire of relevant programmes in a supportive environment which not only empower women with new skills in ICTs but provide an inclusive, safe environment that combines ICT and English language education as well as the opportunity for expanding social networks.

FUTURE TRENDS

In the future, as ICTs become ubiquitous and the digital divide narrows, it is likely that the purpose and appearance of community ICT centers will change. They may look very different because of advances in types, size, and capability of computer hardware and software. However, while there remains concern for impoverished communities, characterized by disconnectedness with each other as described by Robert Putnam (2000), the community centers will have a role in meeting social needs that could remain centered on ICTs.

CONCLUSION

This urban study demonstrates the success of using ICTs with an underserved group of people within a third place environment. The feeling of belonging, attachment, and sense of cohesion by members of this community has developed over time. Initiation into ICTs within a socially inclusive environment and using the computers for useful, relevant purposes has contributed to the successful and changed ICT adoption rate amongst female, particularly immigrant, participants.

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KEY TERMS

Blended Learning: The combining of technology with traditional, face-to-face human assistance.

Community Computing: Provision of technology access within a community context. This may be as simple as hiring the use of a mobile phone to villagers for a few minutes to establishing a physical computing centre within a geographic or virtual community.

Digital Divide: The disparity or distance between those who can and those who cannot access and use ICTs.

ICTs: A broad term that includes technology which has some form of computer and communication capability. These may be mobile phones, radio, television, computers and the different services and applications related to them.

Social Capital: The creation of value and specific benefits that flow from a connected community. These include trust, reciprocity, information, and cooperation associated with social networks.

Third Place: A term coined by Oldenburg (1991) to describe an informal, public place on neutral ground that promotes social equality through people gathering and interacting. Third Place contrasts with first place (home) and second place (work).

Underserved Communities: Communities that lack access to ICTs due to geography, economic conditions, ethnic background, or disability.

Constructing Gender Bias in Computer Science

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INTRODUCTION

Gender bias in technical fields, as in computer science (CS), is a well-known phenomenon. It is shown in presenting computing history as a male victory, while female computing pioneers have been forgotten (Gürer, 1995; Vehviläinen, 1999). The statistics demonstrate gender bias in IT (information technology) workplaces nowadays: only about 20 to 30% of computer professionals are women, and they also have lower salaries than men working in IT (Ahuja, 2002; Pateli, Stack, Atkinson, & Ramsay, 1999). Furthermore, there are studies dealing with CS students (e.g., von Hellens, Nielsen, & Beekhuyzen, 2004). Few studies focus on CS academics. Camp (1997) is one of the rare ones: She describes the shrinking pipeline problem in the USA. Women hold 25% of master's degrees in CS, but only 6% of full professors are women. (Camp, 1997) The CS field is not the only one where female professors are rare. Husu (2001) presents two reasons the general bias is causing: (1) like professionalism in general, academic professionalism is also connected to masculinity and (2) female post-graduate students and newly qualified doctors get less support from their senior colleagues than their male counterparts. Besides supporting to complete studies successfully, older colleagues can support post-graduate students in becoming members of the academic society, which is essential in making an academic career.

This article concerns on the construction of the gender bias among CS academics. I will focus on what happens in everyday practice and how gender bias is reproduced over and over again. I see gender as a process which is constantly under negotiation. In this article, the negotiation process is studied by analysing one case, which is one university department in the technical field. This article focuses on the negotiation of gender within the department; it does not deal with what happens in society or in families (such as taking care of children), although they both affect women's working situation in a department.

The structure of this article is as follows. First, the theoretical background of the relationship between masculinity and technology is described, as it forms the basis for understanding the gender bias in the CS field. Second, the empirical case is described. Third, the suggested explanations for the gender bias are dealt with and connected to the theoretical understanding of gender and technology. Fourth, a forecast of future trends is given, and, finally, conclusions are drawn on the main points of the article.

UNDERSTANDING THE BACKGROUND OF GENDER BIAS

When we try to understand gender bias in the CS field, it is useful to start with thought-models which, according to Wajcman (1991, pp. 137-144), include a connection between masculinity and technology. The connection is not inherent in biological sex difference, but rather a result of the historical and cultural construction of gender (Wajcman, 1991). Although the connection between masculinity and technology is commonly accepted, the views of the mechanism vary. I will present them using the classification of Gill and Grint (1995).

One response to the perceived link between masculinity and technology has come from *eco-feminists*. It sees women as being essentially close to nature because of being rooted in biology. Women's biology, the theory argues, has led to a specific way of "knowing" and experiencing the world which is undervalued. The aim is to retreat into female culture and produce "woman-friendly," feminine technologies. (Gill & Grint, 1995, pp. 5-6.) This perspective is used in practice in creating women's own ICT groups (see, e.g., Vehviläinen, 2000).

For eco-feminists, technology is inherently and inevitably patriarchal, but for *liberal feminists*, technology is neutral. For them, the issue is the different ways in which men and women are posited in relation to technology. (Gill & Grint, 1995, pp. 6-8.) It is important to involve more women in technical fields and to increase their participation in technical education. As technology is seen as neutral, women have to change their attitudes to take the opportunity; it is seen as a question of women's individual choice (Vehviläinen, 2000).

Powerful criticism of both the liberal and the eco-feminist positions has made way for a new approach: seeing *technology as masculine culture* (Gill & Grint, 1995, p. 8). This approach views technology as being much more than simply artefacts or hardware; it is also knowledge and practices involved in the use of technology (based on Grint & Woolgar, 1997). Seeing technology as masculine culture implies that the link between technology and masculinity is reproduced in everyday practices. (Gill & Grint, 1995, pp. 8-12.) According to this approach, gender is not natural or stable, but socially constructed (Wajcman, 1991). Masculinity and femininity are used as abstract frames of reference; a kind of standard that one refers to in the articulation of one's own gender as well as of that of others. Thus, speaking of a connection between masculinity and technology does not mean that technology reflects the capacities of specific men, rather the qualities of some social image of masculinity. (Lie, 1995; Wajcman, 1991, p. 143)

THE CASE OF CSUT

I will describe how the connection between masculinity and technology manifests itself in workplace practice by citing a case, which is the department of CSs in the University of Tampere (CSUT), Finland. Finland is a five-million-inhabitant country in Northern Europe. It is typically presented as a gender equal country, which is evidenced in women's and men's equal proportions of the labour force and in women's and men's equal levels of education: 26% of Finnish women and 22% of men hold academic degrees; women have 51% of the master's degrees and men 49%, but the situation is reversed among PhDs, as 66% of the degree holders are men and 34% women (StatFin, 2004). The discussion of gender equality ignores the fact that the Finnish labour market is strongly segregated into women's and men's work (Kolehmainen, 1999).

The case in this study, CSUT, has about 500 students and almost 100 faculty members. There are 25 teaching posts, ten administrative, and supportive posts, and the rest of the staff are temporary project researchers, whose contracts are typically made for one year at a time. CS is understood as a wide field including five streams: algorithmic, software development, information management, information systems (IS), and interactive technology.

I will focus on the teaching staff, because their posts are thought to be permanent and they are selected with a view to the benefit of the whole department. The teaching staff in CSUT includes ten professors (one of them is an emeritus professor), six instructors and nine senior academic assistants (see Table 1). The professors and instructors have permanent posts, but someone may occupy a post on a temporary basis, typically for a year. Nowadays there are also semi-permanent professorial posts which are for three to five years. Senior academic assistantships are typically postdoctoral posts, in which half of the working time is used for research. They are temporary posts, the standard duration of which is five years (called here semi-permanent), but they may be for one year (called temporary). The teaching staff includes five women and twenty men (see Table 1).

In Finland, it is normal for doctors to continue to work in the same departments where they wrote their dissertations. This is also the case in CSUT: 11 of the 25 male PhDs and three of the eight female PhDs were working in CSUT at the end of 2004. The

Table 1. The number of teaching staff in CSUT at the end of 2004

	Permanent		Semi-Permanent		Temporary		TOTAL	
SEX	M	F	M	F	M	F	M	F
Professor	7	0	0	1	1	1	**8**	**2**
Instructor	2	1	-	-	2	1	**4**	**2**
Senior assistant	-	-	2	0	6	1	**8**	**1**
TOTAL	**9**	**1**	**2**	**1**	**9**	**3**	**20**	**5**
Percent	**90**	**10**	**67**	**33**	**75**	**25**	**80**	**20**

Note: M=male; F=female

Table 2. Number of PhDs in CSUT and the number of posts they hold in CSUT at the end of 2004

	Male		Female	
	PhDs	**Posts**	**PhDs**	**Posts**
1970s	2	1	0	0
1980s	2	2	1	0
1990s	5	2	1	0
2000s	16	6	6	3
Total	**25**	**11**	**8**	**3**

statistics relating to the decade, starting from the first PhD degree at CSUT in the 1970s, are presented in Table 2. In the table, "posts" refers to the number of decades during which PhDs had been working in CSUT by the end of 2004.

Gender bias in CSUT is seen in two points. The first is education. In Finland, women and men hold master's degrees to the same extent, but in the case of PhDs, there is a gender difference. This is also the case in CSUT, where only eight of the 25 (32%) PhDs were taken by women. Besides the smaller number of female PhDs, the female PhDs do not obtain posts in CSUT as often as male PhDs: only 20% of the posts are held by women (Table 1), although the percentage of female PhDs is higher. Furthermore, if we focus on those PhDs who do not work at CSUT, there is also some gender difference. All female PhDs work at universities, but five male PhDs work in industry and three male PhDs at other institutions (not universities); so five female and six male PhDs work in other universities.

SUGGESTED EXPLANATIONS FOR THE GENDER BIAS

In the Finnish universities, the aim is to reach gender equality, which means, for example, that there are an equal number of men and women in every post category. The University of Tampere, like all the Finnish universities, has a plan for increasing equality. CSUT is one of the problematic departments as the gender bias is worse in CSUT than it is in the university as a whole. When the issue is under discussion, two kinds of explanations are suggested by the Head of CSUT and by all the male CSUT professors. The first explanation is that there are no qualified women. The second one is that if there have been some sufficiently qualified women, they have chosen to leave CSUT. I will deal with both explanations and connect them to the above theoretical approaches to gender and technology. After that, I will present some other related issues which have an effect on the construction of such a biased situation.

First, I will deal with the explanation that it is women's own choice not to work in CSUT. Eight women have done a PhD in CSUT. Six of them worked in CSUT during their post-graduate studies but only two continued to work in CSUT immediately after obtaining a PhD. Moreover, no woman from outside CSUT has obtained a post. The male professors in CSUT see this as women's own choice. They talk in the same way as Vehviläinen (2000) claims liberal feminists do: if there are no legal obstacles, the absence of women is a question of women's individual choice. Following this approach, it is relevant to ask women to change their attitudes, not to ask what is wrong with CSUT as women do not want to work there.

The other explanation for women's absence focuses on the alleged lack of qualified women. Eight women have taken their PhDs in CSUT. However, the dissertations of four of the women relate to IS studies, whereas the mainstream in the teaching in CSUT is connected with computer-centred areas (algorithmic, software development and information management). Most often, there is a need for another kind of qualifications than experts in IS have, and, therefore, the four female PhDs are not qualified for those posts. However, the focus of CSUT is not an objective truth emerging from the mass, but is defined and determined by the present professors of CSUT. The focus of CSUT is negotiated among seven permanent male professors. They also decide the focus of new posts; their area, their permanency, the qualifications required, for example. When the male professors decide on the future focus of CSUT, their own subjective views colour the negotiations. They renew their status and power in CSUT, ignoring new, non-represented areas.

In the previous paragraphs, I presented an explanation that follows the views of liberal feminism in assuming that the gender bias is women's own choice. Continuing to the other explanation, we got some evidence which follows the idea of the eco-feminist approach: women have different knowledge than men—or women's science is different from men's science. In CSUT, we can find that some of the female PhDs had gone to new areas which were outside the earlier focus of CSUT, such as the study of gender and technology, as two female PhDs have done. Besides the new subject area, the underlying assumption of research is also different; mainstream IS studies assumes that scientific knowledge ought to be "objective" (Walsham, 1995); instead, feminist researchers (e.g., Haraway, 1991) suggest that knowledge is situated in the knower and his/her standpoint also in the case of scientific research; the two above-mentioned female PhDs endorse this line of thinking. After taking a PhD, one of them changed to work in another university and the other one changed her research area to be more compatible with the mainstream of CSUT.

Besides liberal feminists' and eco-feminists' explanations for gender bias in CSUT, we can also find explanations which are based on seeing technology as masculine culture. When women are educated to male work (as is the case of CS), they encounter a credibility problem; they are not seen as professionals in a male area (Kolehmainen, 1999, p. 147). The claim that there do not exist any qualified female candidates for open posts in CSUT can be seen in this context, which means that no matter what education and how many publications women have, they are not seen as qualified as men. In this context, the above explanations of gender bias in CSUT can be seen as a part of the process in which the existing masculine images are reproduced and renewed.

HOPES—BUT NO PROMISES—FOR CHANGE

A great deal of work has been done to remove the gender bias, and we can see some good results. The number of female PhDs has increased. Also, some positive development has taken place in CSUT: some female PhDs have obtained posts—at the beginning of 2002 there where none. In recent years, women have started to get more funded posts in post-graduate schools. At the end of 2004 there were five men and four women pursuing funded post-graduate studies in CSUT.

There are female PhDs but they are not seen as qualified enough. The evaluation of someone's qualification is made by other members of the scientific community. Becoming a member of the community is essential, but female post-graduate students get less support from senior colleagues than their male counterparts (Husu, 2001). The result is that female PhDs are not seen as qualified academics but they are seen as women—and the stereotypical image presents women with a lack of technical competence (Gill & Grint, 1995).

CONCLUSION

Although recruiting "more girls for IT" is a common target, still, at the same time, it seems that the existing gender bias is reproduced in many ways. I described a current case in Finland, which is a country with a strong rhetoric of gender equality. In the case, the gender bias is as strong as in the USA in the 1990s (Camp, 1997). The causes for bias can be found at many levels—in individuals, workplaces and society. The situation becomes worse as the whole picture is not seen, but different stakeholders see only one aspect of it. The thought-models of the decision-makers in CSUT follow the liberal feminist approach; they ignore social structure and attribute the problem mostly to women themselves. According to them, gender bias is women's own choice. Regarding women's qualifications, the eco-feminist view is followed: women's knowledge is seen to differ from men's; in CSUT women's knowledge is deemed more limited. According to eco-feminists, women's knowledge is better, but in the case of technology it is more limited.

The previously stated views do not focus on gendering processes, as does the approach of seeing the relationship between gender and technology as a cultural phenomenon. In this context, everyday actions are seen in relation to strengthening or questioning the existing gender structure. Every woman who writes a doctoral dissertation in CS takes a small action towards challenging the old gender structure and towards changing the existing gender bias. However, the reproductive process includes opposite actions as well; every case of ignorance among qualified women in the filing of posts reproduces the existing gender bias.

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KEY TERMS

Academic Professional: A person who has a PhD degree and whose qualifications are evaluated and accepted by other academic professionals in the same field.

Computer Science: An academic discipline which is focused on computer software, including programming, algorithms, and databases. In Finland, computer science also includes organisation and human centred IS science.

Eco-Feminism: Sees women as being essentially close to nature. Women's biology, it is argued, has led to a specific way of 'knowing' and experiencing the world, based on emotions, intuition and spirituality. According to this perspective, society is made up of two discrete cultures—a male (patriarchal) one and an undervalued female one (Gill & Grint, 1995, pp. 5-6).

Gender Bias: Exists when, in some situation, women's and men's number, status and treatment differs to such an extent that it is disposed to favour one side (mostly men) against the other.

Gendering: A process in which gender images, norms, expectations are constructed.

Liberal Feminism: An approach of gender and technology studies which focuses on reaching equal access to technology and recruiting more women for technical fields. As technology is seen to be neutral, the main problem is women's attitude (Gill & Grint, 1995, pp. 6-8; Vehviläinen, 2000).

Technology as Masculine Culture: An approach of gender and technology studies, which includes the understanding of masculinity as an abstract frame of reference; a kind of standard one applies to the articulation of one's own as well as other people's gender. Men can use technical objects to demonstrate masculine capacities as they arouse associations of masculinity in others (Lie, 1995, p. 382; Wajcman, 1991, p. 143).

C

Critical Research on Gender and Information Systems

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INTRODUCTION

In 1991 Orlikowski and Baroudi published a seminal paper about the role of epistemological lenses in shaping information systems (IS) research. Citing Chua's (1986) classification of research epistemologies they went on to describe the way in which each of three lenses—positivist, interpretive, and critical—influences the conduct of IS research. They concluded with the observation that whereas positivism dominated the IS research landscape, interpretive research was beginning to make an appearance. They also noted the dearth of critical IS research. Throughout the 1990s a few papers on critical research appeared. Myers' (1997) paper on critical ethnography helped to bridge the understanding gap between interpretive and critical research. Ngwenyama and Lee (1997) used the critical lens to guide their approach to examining information richness theory. Doolin (1998) argued that a research approach based on critical theory is needed in order to view information technology within a broader context of social and political relations. However, in the 2000s there has been a significant increase in the focus on critical research, as evidenced in an increasing number of publications, conference streams, special issues, and academic electronic networks concerned with discussing critical IS[1].

It can be argued that the social nature of activities associated with the development, implementation, and use of IS and the management of people who carry out these activities leads naturally to considerations of social and political power. This consideration of power, in turn, encourages critical analysis. In the social sciences the term critical is used to describe a range of related approaches, including critical theory (Horkheimer, 1976), critical operational research (Mingers, 1992), critical ethnography (Forester, 1992), and critical management studies (Alvesson & Willmott, 1996). Despite some areas of commonality, critical researchers draw upon a broad range of social theories. These include, for example, the Frankfurt School of critical social theory (Horkheimer, 1976), actor-network theory (Latour, 1991), Marxism (Marx, 1974), feminist theory (Wajcman, 1991), and the work of Bordieu (1990), Dooyeweerd (1973), Foucault (1979), and Heidegger (1953).

BACKGROUND

It can be further argued that the topic of gender and IS is particularly suitable for critical research insofar as it is concerned with power relations and underrepresented voices in the context of gender and information technology use (Kvasny & Trauth, 2002). The choice of a critical rather than a positivist or an interpretive epistemology for research on gender and IS, however, has definite implications for both the perspective on the topic and the way it is researched (Howcroft & Trauth, 2004).

When the positivist epistemology is applied to the topic of gender and IT, the objective is typically to discover *whether* and *where* there are gender differences. The aim is to uncover gender distinctions, not to explain or theorize why these distinctions have arisen and continue to exist. Examples of this include investigations of women's vs. men's use (adoption, acceptance, etc.) of IT (e.g., Gefen & Straub, 1997) and women's participation rate in the IS profession (e.g., Carayon, Hoonakker, Marchand, & Schwarz, 2003; Truman & Baroudi, 1994). Further, the theory underlying positivist gender research is often essentialist whereby observed gender differences are understood to arise from the dichotomizing of male/female roles that, in turn, are assumed to generally derive from bio-psychological differences (Wajcman, 1991).

Much of this research is predicated on negative assumptions about women (such as assumptions that women are inherently less technologically competent than men) and is not typically informed by the gender literature (Adam, Howcroft, & Richardson, 2004). This type of research is typically motivated by a desire to advance managerial objectives. For example, it might be to consider gender as a factor of production in better harnessing diversity in pursuit of effectiveness and productivity (e.g., Gallivan, 2003; Igbaria & Baroudi, 1995; Igbaria & Chidambaram, 1997; Venkatesh & Morris, 2000). Problems of inequality are viewed in terms of wasted resources, with increased equality being promoted as a means of optimizing efficiency. The main drawback of this research approach is that the investigation remains on the surface of observable and documentable differences. In so doing, it offers an unproblematic treatment of the topic in which the observation of differential treatment in the workplace by gender has a tendency to become the explanation (i.e., that men and women are treated differently in the IT workplace *because* they are different with respect to their relationship to IT and IT work in some relevant, essential way). Further, by offering only managerialist perspectives, positivist gender and IS research privileges one perspective over others. Hence, the gendered aspects of IT use, for example, are not considered from the perspective of those experiencing it.

In contrast, interpretive studies of gender and IS focus on developing a better understanding of *how* these gender differences in IT use and IT work have come about. The objective is to add context to the observations about gender and IT. This research invokes such theories as social construction (e.g., Nielsen, von Hellens, Greenhill, & Pringle, 1998; Tapia, 2003) or individual differences (Trauth, 2002; Trauth, Quesenberry, & Morgan, 2004) in developing theoretical explanations that incorporate social influences underlying inequality (e.g., observable differences) between the genders. The point of view of this research is not just managerialist; the motivation is also to advance our understanding of the relationship between gender and IT by understanding the point of view of the women IT users. Thus, an interpretive examination of gender and the IS profession might explore the influence of national culture on the social construction of gender identity as it relates to the IT workforce (Trauth, 1995; Trauth, Nielsen, & von Hellens, 2003; Trauth, Quesenberry, & Yeo, 2005). However, a limitation of the interpretive approach is that the focus is on *understanding* the societal influences, not *questioning* them. It is directed at coping with the dynamics of inequality, not challenging the legitimacy of underlying social influences or undoing them.

MAIN THRUST OF THE ARTICLE

In response, the objective of critical gender and IS research is to investigate *why* gender inequality exists. The motivation is to understand and challenge power relations that reproduce inequality (Kvasny, in press). Critical social theory, postmodernism, and feminist theory (Adam 2002; Adam & Richardson, 2001; Kvasny, Greenhill, & Trauth, 2005), for example, are used to inform the search for the underlying causes of gender inequality. Thus, a critical perspective on gender and IT might concentrate on the gendered nature of the workplace and technological skills (Wilson, 2002). This moves the research away from positivist and interpretive themes of profitability, efficiency, effectiveness, and gender identity, and towards themes of control, resistance, and inequality.

Critical researchers also embrace the social and political influences on their research, rather than negate these assumptions and beliefs. They aim to balance their interest in the people being studied with an awareness of less explicit ideological and structural forces. This is in contrast to what Bhaskar (1979) has described as the “linguistic fallacy,” the claim adopted by many interpretivists that subjects, concepts, meanings, and accounts of their actions cannot be criticized. In critical research the spotlight shifts from an exclusive focus on individuals, situations, and local meaning to the systems of relations, which make such meanings possible. This is not to suggest that experiences are ignored; rather they are balanced against issues of an ideological nature that may frame the experiences and ascribe additional meaning.

The use of critical IS research to study the topic of gender and IS enables new explanations and theories to become available. It addresses positivist limitations by offering alternatives to managerialist perspectives and theories. It addresses interpretive limitations by considering power relations, marginality, and dominant discourses in the organizational and societal context. The use of critical theories enables the researcher to shed theoretical light on the subtle ways in which gender inequality is operationalized in technological disciplines in the academy and the workforce.

CONCLUSION

While the use of a critical epistemology for research on gender and IS would seem to flow naturally from the nature of the topic, there is surprisingly little critical gender and IS literature, with some notable exceptions.[2] This situation suggests a fertile area for future research. In making the choice of a critical epistemology, however, it is important to recognize the methodological implications of doing so. First, while there is little critical gender and IS literature, there is even less empirical critical gender and IS research literature. This dearth of empirical research means that there are few examples in the literature upon which researchers can currently model their work. Second, whereas positivist research endeavors to remove bias from the research account, both interpretive and critical research acknowledge the inherent bias in all research. But because of the agenda of highlighting the power dynamics at work in organizations, critical research is typically more vulnerable to political issues when attempts are made to publish such work. The diffusion of critical research in IS is being enhanced by critical IS books, critical IS conferences, and special issues of journals on critical IS, which provide new outlets for the dissemination of critical IS research. It is hoped that at least some of this emergent research will address the topic of gender and IT.

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KEY TERMS

Actor-Network Theory (ANT): Developed by Michel Callon and Bruno Latour, ANT is a social theory that explains the interrelated connections between human and nonhuman actors. At the core of this theory is the understanding that technology and society are mutually constitutive.

Critical Research: Research that critiques the status quo through the exposure of what are believed to be deep-seated, structural contradictions within social systems, thereby transforming these alienating and restrictive social conditions (Orlikowski & Baroudi, 1991, p. 5-6).

Feminism: A social, political, economic and intellectual movement that is concerned with removing the subordination of women. With regard to research, feminism searches for ways in which women's positions in life can be made equal with those of men (Adam, 2002).

Feminist Theory: According to Wajcman (1991), there is no single "feminist theory" but rather a diversity of perspectives including: cultural feminism, eco-feminism, liberal feminism, postmodernism, radical feminism and social feminism. This body of theories argues that inquiry should be based on the "lived sociopolitical experiences of women" because their perspectives afford an alternative view of social relations to that of mainstream empirical epistemologies (Schwandt, 2001, p. 93).

Interpretive Research: Research directed at understanding the deeper structure of a phenomenon within its cultural context by exploring the subjective and intersubjective meanings that people create as they interact with the world around them (Orlikowski & Baroudi, 1991, p. 5).

Positivist Research: Research that assumes the existence of *a priori* fixed relationships within phenomena which are typically investigated with structured instruments. The purpose of this research is primarily to test theory (Orlikowski & Baroudi, 1991, p. 5).

Postmodernism: An intellectual movement that rejects modernist principles and practices. It argues, instead, that there is no single truth or reality. Since multiple versions of truth or reality exist, it argues for pluralist principles and practices (Webster, 2002, Chap. 9).

ENDNOTE

1 An example of books is Howcroft and Trauth (2005). Examples of special issues of journals devoted to critical research include *Data Base* (2001/2002), *Journal of Information Technology* (2002), and *Information Systems Journal* and *Information Technology & People* (forthcoming). Examples of conferences with a critical IS stream include the Critical Management Studies conference (1999, 2003, 2005), Critical Research in IS Workshops (2001, 2004), and a critical stream at the Americas Conference on IS since 2001.

The Cross-Cultural Dimension of Gender and Information Technology

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INTRODUCTION

The underrepresentation of women in the information technology (IT) sector has been widely studied in the contexts of western countries such as North American and Western European countries. These studies indicate that the underrepresentation of women in the IT sector is unveiled in multiple perspectives, including IT access, the development, adoption and use of IT, IT education, and the IT workforce in general and within the IT workforce structure itself (e.g., different levels of IT positions) (Cooper & Weaver, 2003; Gürer & Camp, 2002; Hartzel, 2003; Klein, Jiang & Tesch, 2002; Margolis & Fisher, 2002; Rommes, 2002; Trauth, 2002; von Hellens, Neilsen, & Beekhuyzen, 2001; Webster, 1996).

Why is it important to study issues related to gender and information technology? First, it is argued that the information technology sector should value and leverage all kinds of diversity (including gender diversity as one dimension) to enhance productivity, to facilitate IT innovation, and to develop IT for a wide variety of people (Avgerou, 2002; Roberts, 2003; Trauth, Huang, Morgan, Quesenberry, & Yeo, 2006). Second, it is also argued that women's underrepresentation in and exclusion from information technology can be attributed to power and socio-cultural reproduction of inequality through technology development and use, and the historically social-construction of technology fields as "masculine" domains, which result in a gendered digital divide (Cockburn, 1985; Kvasny & Trauth, 2002; Kvasny & Truex, 2001; Wajcman, 1991, 2004; Woodfield, 2000). Ignorance or failure to address issues related to gender and IT will further marginalize women's participation in future economic and social development, and will endanger social equality and social welfare in general (Kvasny & Trauth, 2002).

A significant trend of the contemporary information technology industry is towards globalization, which is manifested through a variety of established practices such as IT offshore outsourcing, global software development, and innovation through global R&D (research & design) collaboration (Sahay, Nicholson, & Krishna, 2003; Walsham, 2000, 2001, 2002). Such a globalization trend of the IT industry and market has put forward new challenges to gender and IT research, to incorporate the cross-cultural dimension. Similar to the rationale for studying gender and IT in developed countries (leveraging diversity and improving social inclusion), Hafkin and Taggart (2001) argued that it is imperative to examine the cultural factors while studying gender and IT in developing countries.

Although the research on the cross-cultural dimension of gender relations with information technology is limited, Galpin (2002) pointed out that the underrepresentation of women in IT seems to be a worldwide phenomenon indicated by statistics. Galpin (2002) also pointed out that there is a wide range of participation in IT by women, which is influenced by complex cultural and societal factors that are different from country to country. Models related to gender relations to IT developed in certain socio-cultural contexts may not be applicable to others (Clarke & Teague, 1994a; El Louadi & Everard, 2005; Mukhopadhyay, 1996, 2004).

In addition to the importance of studying gender and IT within a specific cultural context, there is another perspective of the cross-cultural dimension of gender and IT: the increasingly diversified global IT workforce as a result of the IT skill shortage, global IT outsourcing, and other global IT collaborations. For example, under the pressure of the skill shortage of the IT workforce in America, the IT institutions and industry turn to the global intellectual pool for recruiting talented international students and skilled IT workers through F-1 and H1-B visas (National Research Council, 2001). According to the 2005 ITAA (Information Technology Association of America) report, the representation of Asian IT workers in the IT workforce doubled the number of Asian worker in the overall workforce in America (ITAA, 2005). Globally, an increasing number of countries have a maturing IT sector, which enables them to enter the global IT outsourcing market or to engage in globally distributed collaborative software work through virtual environment (Trauth et al., 2005). The mobility and cultural diversity of the global IT workforce will add more complexity to articulate their gender relations to IT since individuals may have different cultural backgrounds and experiences.

Therefore, it is important for scholars and practitioners to explore the cross-cultural dimension of gender and IT to understand how the nuances of different cultural influences shape women's relations with IT, to build knowledge with respect to the plural perspective of gender and IT research, and to prepare future global IT workforce. In this article, I first articulate the theoretical underpinnings of cross-cultural dimension of gender and IT research, then review some current studies related to this research area, and finally discuss some future research agendas.

BACKGROUND

The theoretical explanations about why women are underrepresented in IT education and the workforce are complex in nature (Adam, Howcroft, & Richardson, 2002, 2004; Webster, 1996). Those theories attempt to articulate the gender IT gap from either the technology perspective (including the IT sector environment) or the people perspective (e.g., women). From the technology perspective, there are two theoretical orientations: technology determinism and social shaping of technology. From the people perspective, there are three theoretical orientations: essentialist theory, social construction theory, and Individual Difference Theory of Gender and IT (Trauth, Quesenberry, & Morgan, 2004).

Technology determinism views technology as a value-free artifact without any biases, and the impacts of technology on society are self-directed and universal. It neglects the influences of socio-cultural contexts in which the technology is created and used. Social shaping of technology, on the other hand, views technology as a product of socio-cultural and power relations and the impacts of technology on society are shaped by the socio-cultural beliefs embedded within the technology and the societal attitude towards the technology. For example, Kvasny and Truex (2000) argued that power relations and controls are embedded in technology and in society's attitudes towards technology, and hence new technology tends to "reify the dominant relations in the existing social order." The embeddedness of social order in technology will privilege certain groups while disempowering others (Kvasny & Trauth, 2002). Technology related educational disciplines and industrial sectors have been historically dominated by men and hence are embedded with belief systems that are engendered with "masculinity," which may be exclusive of women's participation (Cockburn, 1985; von Hellens et al., 2004; Wajcman, 1991, 2004). Driven by this theoretical orientation, researchers recommend bringing IT closer to women: changing technology development methods, increasing women's participation in system development and implementation, modifying the "masculine" culture of IT at various levels from societies, to industries, and to organizations and educational institutions.

The essentialist theory argues that men and women are differentiated by their biological differences; such differences are inherent and fixed and thus act as main causes to determine their different relationships with IT (Adam et al., 2004; Trauth et al., 2004). Similar to the technology determinism, the essentialist theory only emphasizes the intrinsic internal differences between men and women and overlooks the influences of social contexts in which both technology and people are embedded. Social construction theory views gender identity and gender relationship with IT as on-going negotiation processes in social interactions, in which the influences of various factors are relevant and important (Trauth et al., 2004; von Hellens et al., 2004; Wajcman, 1991; Webster, 1996). Driven by this theoretical orientation, researchers recommend bringing women closer to IT, which include setting up mentoring programs, providing convenient child-care facilities, and developing initiatives to facilitate work-life balance of female IT workers.

Trauth (2002) pointed out that social construction theory of gender and IT tends to separate men and women as two separate socio-cultural groups, which mainly focuses on the differences between the gender groups while overlooks the differences within the gender group. Within the gender group, differences such as ethnicity background, family, social class, individual life experiences, age, individual personality and attitude also play important roles in shaping one's relationship with IT (Kvasny, 2003; Trauth et al., 2004). Trauth argued for focusing on individual level of analysis and developing Individual Difference Theory of Gender and IT (Trauth, 2002; Trauth et al., 2004).

MAIN THRUST OF THE ARTICLE

Theoretical Underpinnings of Cross-Cultural Dimension of Gender and IT

In his research on cross-cultural information systems production, use, and management, Walsham (2001, 2002) emphasized the importance of examining the cultural diversity and argued that the existing local socio-cultural context is a critical factor in mediating the globalization process in a specific context and, in turn, will have an impact on the complexity of globalization. Similarly, to study the cross-cultural dimension of gender and IT, the underlying theories should be sensitive to and account for the dynamics of cultural diversity. Evidences show that cultural diversity and its influences on gender and IT is connected to three theoretical perspectives: social construction of gender relationship with IT, social shaping of technology, and Individual Difference Theory of Gender and IT.

El Louadi and Everard (2005) examined current labor force condition of Arab countries, and more particularly Arab women. They pointed out that because of the Arab cultural influences, the future opportunity of engaging Arab women in IT work may lie in telework, which can bring work and information technology into the home where Arab women can be professionals and care for the family at the same time. This is an example of the distinct Arab socio-cultural influence on women's relationship with IT.

Nielsen et al. (1998) studied non-Asian and Asian female students enrolled in IT disciplines in Australia and the differences among their perceptions of IT educations and careers. Their study showed that both non-Asian and Asian females had similar views about the IT professions. However, Asian female students were more inclined to choose IT related subjects despite their negative perceptions of IT professions because of the future prospects of employment opportunities (Nielsen, von Hellens, Greenhill & Pringle, 1998; Nielsen, von Hellens, Pringle & Greenhill, 1999). Such a choice is influenced by collectivist characteristic of Asian culture and is based on practical consideration, as compared to the "free-choice" decision making in most Western cultures. The research by Geary on comparing children's mathematic achievements in different countries also supports this argument (Geary, 1996; Geary, Bow-Thomas, Liu & Siegler, 1996): Asian culture emphasizes practical reason (e.g., usefulness) in decision-making while Western culture emphasizes free choice. The studies by Nielsen et al. (1998, 1999) indicate that although the perceptions of IT professions might be similar between Asian and non-Asian women (e.g., the social shaping of technology is similar), their relationships with IT are different because of the cultural influences. Also their studies are situated in one national context, Australia, which implies that researchers should pay close attention to the differences within gender groups (in this case, Asian and non-Asian Australian female IT students). It also implies that cross-cultural influence is an important dimension in studying the Individual Difference Theory of Gender and IT.

An early study by Clarke and Teague (1994a, b) is also about the Australian context. Based on interview data, their study shows that Asian female CSE (Computer Sciences and Engineering) students did not see computing as a male domain and they also received direct encouragement from family to pursue computing related secondary studies. This is an example of cultural influences on both social shaping of IT and social construction of gender relationship with IT. Clarke and Teague (1994b) pointed out that "the differences within gender groups are greater than the differences between gender groups" (p. 259), which indicates the relevance and important in studying the individual difference of gender and IT.

The study by Mukhopadhyay (1996, 2004) also strongly supports considering a cross-cultural dimension in studying gender and science (although IT is not a central subject in this study, it is closely relevant). Mukhopadhyay (1996, 2004) challenged both the essentialist theory and those American theories of gendered science that embodied long-standing American cultural models to other socio-cultural contexts. She pointed out that it is the Indian cultural model of family, gender, and science that influences the Indian women's academic decision-making process, and hence results in a predominantly male scientific community in India. Mukhopadhyay (2004) also stressed that:

We need to explore the processes through which individuals internalize and utilize what Strauss and Quinn (1997) call "public culture" as it relates to gender, schooling, academic subjects (mathematics, science, etc.), family, kinship, and marriage. We need to understand more about how and why some messages have more motivational force than others, for some girls more than others, and how they mediate math and science attitudes, achievements, and choices. (p. 487)

Current Research on Cross-Cultural Dimension of Gender and IT

A comprehensive review of current research on cross-cultural dimension of gender and IT is beyond the scope of this article. Here, I would like to provide a brief overview. Current research on cross-cultural dimension of gender and IT can be classified into two categories. One category consists of comparison studies that investigate how and why the women's participations in IT are different in different countries. The study by Galpin (2002) provided a good summary and references for this type of study. Another example is the study by Hafkin and Taggart (2001), which focuses on studying the developing countries. The primary objectives of those studies are: to understand the nuances of different socio-cultural influences on gender and IT in different countries; to come up with solutions to improve women's participation in IT that fit with a specific socio-cultural context; and to see whether or not some practices and experiences can be transferred from one country to another country.

Another type is to situate the cross-cultural dimension of gender and IT within a specific societal context while studying how the diverse cultural backgrounds of different women may influence their relationships with IT. The studies by Clarke and Teague (1994a), Nielsen et al. (1998, 1999), and by Mukhopadhyay (1996, 2004) are the examples. The primary objectives of these studies are to critically address the cultural influences on women's relationships with IT within gender groups, and to leverage the influences of cultural diversity on IT to a great extent. The number of this type of study is limited compared to previous types. However, the importance of this type of research is increasing due to the globalization of the IT market and industry and the mobility of IT professions.

FUTURE TRENDS AND CONCLUSION

In this article, I argue that it is important to investigate the cross-cultural dimension of gender and IT because of the contemporary globalization phenomena. From the theoretical perspective, I discuss how the cross-cultural dimension can be incorporated into the social shaping of technology, social construction of gender and IT, and individual differences perspective on gender and IT. However, the number of studies in cross-cultural dimension of gender and IT is limited.

Therefore, one of the future research agenda items is to have more studies in this area to address the influences of cultural diversity. Another future research agenda item is to further incorporate the cross-cultural dimension into the theoretical developments of gender and IT. To do so, we need to encourage interdisciplinary discourse among different disciplines, and also global collaborations in gender and IT research.

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KEY TERMS

Essentialism: The assertion of fixed, unified and opposed female and male natures (Wajcman, 1991, p. 9). This theoretical perspective is used to explain the underrepresentation of women in the information technology field by arguing the existence of "essential differences" between males and females with respect to engagement with information technology.

Individual Differences Theory of Gender and IT: A social theory developed by Trauth (Trauth, 2002; Trauth et al., 2004) that focuses on within-group rather than between-group differences to explain differences in male and female relationships with information technology and IT careers. This theory posits that the underrepresentation of women in IT can best be explained by considering individual characteristics and individual influences that result in individual and varied responses to generalized environmental influences on women.

Social Construction: A theoretical perspective articulated by Peter Berger and Thomas Luckmann (1967) that focuses on social processes and interactions in the shaping of actors. This theoretical perspective is used to explain the underrepresentation of women in the information technology field by arguing that technology—socially constructed as a masculine domain—is in conflict with socially constructed feminine identity.

Crossing the Digital Divide in a Women's Community ICT Centre

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INTRODUCTION

This article examines the role of community-based training initiatives in enabling women to cross the so-called digital divide and become confident users of ICTs. Drawing on a case study of the Women's Electronic Village Hall (WEVH) in Manchester, United Kingdom, one of the first such initiatives in Europe offering both skills training and Internet access to women, the article will illustrate the impact that community-based initiatives can have in challenging and changing prevailing gendered attitudes toward technology. Gendered constructions of technology in dominant discourse suggest that women must also cross an internal digital divide, involving a change in attitude and self–identification, before they can see themselves as technically competent. Learning about technology is intimately linked to learning about gender, and the performance of skills and tasks that are culturally identified as masculine can be an empowering step for women, successfully challenging preconceived gendered relationships with technology.

The WEVH occupied a unique position, acting as a model for other women's ICT initiatives and influencing the development and proliferation of other community-based ICT access projects. There were two main motivating forces behind its setting up in 1992. The first was a shared vision of the potential for ICTs to be used as a tool to combat social exclusion. The second was a feminist commitment to redressing the inequalities and underrepresentation of women in computing. Both these perspectives formed an important backdrop to the growth and development of the organisation and have continued to inform its strategic plans.

BACKGROUND

The Digital Divide

The context in which the WEVH was set up in the early 1990s was the first wave of initiatives concerned with tackling the so-called digital divide. During the decade that followed, there was a proliferation of initiatives driven by both British government and European policy aimed at ensuring that the emerging information society was inclusive of all citizens including specific measures for the participation of women.

While the personal ownership of PCs (personal computers) and home-based access to the Internet has increased at a rapid pace in Britain since the early 1990s, it is still the case that significant sections of the population do not have access to computers or the Internet. Moreover, those who are digitally disadvantaged often do not have the skills to take advantage of the potential that ICTs have to offer[1] (Office of National Statistics, http://www.statistics.gov.uk). Community-based ICT facilities to tackle the so-called digital divide were seen as one of the key strategic tools in community development and urban regeneration that was reflected in policies at the local, national, and European level. [2]

During the first wave of measures to tackle the digital divide in Europe in the early 1990s, women were considered one of the primary target groups for ICT training and access. The emerging Internet at that time was predominantly used by "techie" men, designed and implemented without the perceived need for inclusive strategies, and immersed in a strongly male-identified culture. At the time of its creation, the WEVH was therefore responding to a clear need to tackle gender inequality, an issue that was considered self-evident to all concerned. Over a decade later, following the transformation of user interface design and the creation of the World Wide Web, Internet access reached the majority of the British population, and there is now only a small difference in usage between men and women (Citizens Online, 2005).[3] While this is certainly an improvement, this simple analysis of Internet usage ignores the realities of women's continued underrepresentation in the IT industry, from their lack of influence on content and applications development to widespread inequalities in women's employment opportunities in IT. Yet it seems that the increase in women's access to the Internet and basic ICT skills has seen a reduction in public commitment to resources for women-specific ICT initiatives, which had historically been justified by the statistics of Internet usage.

While quite rightly addressing important social-exclusion issues, the notion of the digital divide as it has been used in British policy debates is somewhat limited, assuming a one-way process in which access to a computer and the Internet enables individuals to cross over and join the digitally empowered. However, there are significant numbers of ex-Internet users or refusers, that is, those who have stopped using the Internet either by choice or because they no longer have access: "It is clear ... that overall growth patterns of Internet usage conceal significant changes in usage by different sub-populations, including some evidence of drop off by particular groups" (Woolgar, 2000, p. 5).

Community ICT Access

The creation of the WEVH was part of a growing movement of community ICT initiatives that were developed at the local level both in Britain and elsewhere in the early 1990s. All of the initiatives had the common aim of providing "supported access in a location other than work or home" and "access to ICT in a social context" (Liff, Watts, & Stewart, 2000, p. 2-3). They have been known by a range of names including e-gateways, telecottages, telecentres, electronic village halls (EVHs), ICT learning centres, cybercafes, telework centres, community teleservice centres, and so on.

The idea of the electronic village hall was based directly on a model pioneered by Lars Qvortrup in Denmark, and was influenced by a growing counter-culture in the USA of online community networks and bulletin boards such as The Well (Rheingold, 1995). The creation of urban electronic village halls was part of a vision for the city of Manchester that combined community grassroots involvement with a local-authority public-information service known as the Manchester Host, an e-mail and bulletin-board system that local people could connect with and use to communicate with each other that would have shared community space as well as online databases supplying information. A cornerstone of the vision was that local people who did not have access to computers in their homes would be able to use these services at community access points: There were already some examples of these kinds of community centres operating successfully in rural Scandinavia. The concept of an electronic village hall in Manchester was a deliberate attempt to adapt the concept of a rural telecottage into an inner city context (Leach & Coppitch, 2005). The name implied that the centres would function as cozy, friendly local meeting places where technology could be made accessible and simple to use. In 1990, there was no World Wide Web, just text-based, command-line interfaces, so it was imperative that there were people to enthuse and support new users who might find the technology intimidating. The centres would be staffed by enthusiastic "telemateurs" who would raise awareness and act as missionaries within the communities. This was very important: The projects were not responding to expressed needs, but were proactive in trying to create those needs and a critical mass of users on the Manchester Host. As well as the WEVH, two other electronic village halls were set up in geographical neighbourhoods, providing services to spatial rather than virtual communities. The EVHs were charged with wide-ranging social and economic aims, including a regeneration agenda supporting and encouraging the development of local communities and businesses through the use of ICTs.

Women and ICT: Finding a Space

While this political context in the city of Manchester was one strand in the WEVH story that informed its strategic and financial development, it was the feminist agenda of empowering women through the use of technology that formed the core of the organisation's vision. In looking at how the experience of the WEVH connects with theories about gender and technology, it is possible to trace a changing awareness and perspective within the organisation during its historical development, which reflected changes in external environments and political climates within what might loosely be called the women's movement in Manchester.

The original proposal for the WEVH was to house the project in a women's community centre, a building that had been home to the famous Pankhurst family. (Emmeline Pankhurst and her daughters were leaders of the British suffragette movement in the early years of the 20th century, and their house became an important focus for the women's movement in Manchester in the 1980s.) However, differing perceptions and attitudes toward technology resulted in the project being located elsewhere. Existing workers at the centre who had been immersed in the political struggles of the 1980s adopted what could be described as an ecofeminist position: They saw technology as something to resist rather than embrace and were afraid the project would take over the work of the centre. There was a level of technophobia that sprang from a tradition of radical feminism in which technology was to be resisted as part of the patriarchal, military, industrial complex, a biologically determinist viewpoint advocated by writers such as Susan Griffin and Adrienne Rich (Grint & Gill, 1995). The 1980s women's movement had been characterised by peace and antinuclear protests, the emergence of green and environmental causes, anti-capitalism, and a celebration of women's creative diversity. The new information and communication technologies were seen to be associated with masculine values and were perceived as a threat to hard-won women's space.

Equality of Opportunity

In fact, from its inception, the WEVH can be seen to have subscribed to a liberal feminist agenda in relation to technology (Henwood, 1993) in that the aim was to get more women into technology by increasing the supply of skilled women. Women were identified as lagging behind in their involvement with new technologies, and the new centre would help them catch up by offering special programmes of training. This approach came through the conviction that providing opportunities for skills development would bring about change and was consistent with the dominant equality-of-opportunity discourse current at that time. This was an approach prevalent in women's training centres throughout Britain, which provided access to training in nontraditional skills. This agenda was also overtly highlighted in the criteria of funding agencies. Many of the training and research projects were funded by the European Union and were based on the underlying justification that there were skills shortages in a particular industry (in this case IT) and women were underrepresented in these occupational sectors. The solution was to increase the number of women in these sectors by encouraging them to develop skills and enter work in ICT. Training was carried out within a culture of nurturing and supporting women, which drew on traditional feminist pedagogical methodologies—peer support group, personal growth and consciousness raising, a celebration of the hidden achievements of women in history, and so on (Ellen & Herman, 2005).

While individual women certainly achieved personal success, not surprisingly, very little change was brought about to the gender balance in the IT industry as a whole. Although women consistently found employment directly after their training (http://www.wevh.org.uk), only a handful of women went into areas of IT that were highly gender segregated such as computer networking. Those women who went on to study computing or IT in higher education mainly went into so-called "soft" or hybrid degrees, not into the traditionally male-dominated subjects such as computer science. This is hardly surprising given the scale of the problem: The equal opportunities or liberal feminist agenda, the "women-into" approach, has not generally been successful in achieving the large-scale restructuring of gendered occupational segregation in technology (Ellen & Herman, 2005). In fact, any attempts to rectify the unequal gender balance in segregated occupations without tackling underlying cultural norms seem destined to remain marginal in their impact.

Cultural change is necessary at both the macro and micro level. Parallel to the discourse of equal opportunities and the liberal feminist analysis of gender and technology, the WEVH can be seen as having the more subversive strategy of challenging the perception of "technology as masculine culture" (Wacjman, 1991, p. 137). Understanding technology as culture (both as the work environment in which technology is used as well as the artefacts and hardware themselves) has enabled the organisation to challenge attitudes that women had about themselves and their own expectations. Women experienced participation with technology as an appropriate activity rather than a transgressive act to be resisted. An environment in which trainers and technical staff were all women and learning was experienced in an all-female group provided a stark contrast to the cultural norm of technology as masculine. The women-only training environment was crucial to success: It allowed skills to be acquired in a gender-neutral way without having to refer to dominant cultural assumptions of gender-appropriate knowledge.

Empowerment and Cultural Change

Even within a small-scale environment such as the WEVH, it has been possible to challenge deeply held cultural attitudes. One of the key strategies was to ensure that women had hands-on experience of touching technology, which has often been a taboo activity for women. Throughout all training provision, an emphasis was placed on giving women the empowering experience of handling pieces of technological equipment and to see this as fun and enjoyable. In introductory courses, women had to assemble their own PCs by plugging in the correct leads; in the networking course, women were installing motherboards and fitting new cards, crawling under tables to connect wires. All trainees were taught to carry out routine maintenance and troubleshooting procedures.

These experiences are empowering not only because they develop useful skills, but also precisely because they are transgressive and not what women would have expected of themselves. These women were not performing gender in the way in which they had been used to, and by doing so, they were subverting received notions of gender-appropriate behaviour or performance (Butler, 1999). This empowerment was something that women could transfer to other areas of their lives, and many expressed how they had become more confident and increased their own self–esteem. One woman says, "the training I received at the WEVH has had an incalculable effect on my life…I learnt about the logic behind computer systems which set both my capabilities and my imagination free" (Dyson, 1999, p. 78). By challenging internal stereotypes about the type of knowledge and skills considered appropriate for themselves as women, they could then apply this knowledge to other situations.

A final perspective through which this process of bringing women into a self-confident engagement with technology can be viewed is that of Haraway's (1991, p. 149) notion of the cyborg. As women acknowledge and develop their own relationships with technology through the acquisition of skills, they gain an understanding of and positively embrace the role that technology does and will play in their lives. They recognise that they "are all hybrids of machine and organism…are all cyborgs," and see technology as part of their own future rather than something external to them: "[The WEVH provides] the right atmosphere for any woman, of any background, to attain her best. It made us feel positive about the future, new technology and picture ourselves in it" (Dyson, 1999, p. 75). Opening up opportunities for women to positively use and shape technology has been the ultimate goal for the WEVH; as much as skills and knowledge, it is attitudes that must be changed for this process to succeed.

FUTURE TRENDS

It is clear from this case study that community-based women's training centres such as the WEVH can play a vital role in supporting women to become skilled and confident users of ICT and cross over the digital divide. During the rapid expansion of Internet usage since the late 1990s, the WEVH and similar centres have been important in ensuring gender equality in access to ICTs and pioneering new approaches to empower women in their use of technology. Yet, while Internet usage has now reached the majority of the British population and is relatively equal in terms of gender, there is still a need to support those who are digitally disadvantaged. The lack of Internet access and ICT skills is closely correlated with other indicators of economic disadvantage such as educational achievement, ethnicity, age, and employment status. Thus, for the foreseeable future, there will continue to be a role for women's centres to provide support and empowerment for a significant minority of women who would otherwise not have the skills or confidence to use ICTs. And while the prevailing culture of the IT industry as a whole continues to be male dominated with significantly fewer women employed in this sector, it is important that women's ICT initiatives continue to offer spaces that are free from mainstream gendered constructions of technology, and a basis from which to campaign for change.

CONCLUSION

The original aims and objectives of community ICT initiatives have been clearly tied to an agenda of local democracy and participation. In the case of the WEVH, the fear was that ordinary women would be excluded from participating in the new information society and therefore it was imperative to provide public access points for those without access to equipment at home or at work. But it was always clear that democratisation included not only the means of participation (i.e., hardware and connectivity), but also the skills and attitudes needed to effectively make use of these. For women in particular, there were internal messages and cultural barriers that also had to be overcome. This vision has remained but has had to adapt to a wide range of changes. Technological developments and the wider ownership of PCs have altered the role from one of advocacy and awareness to that of fulfilling expressed needs.

The WEVH has been a unique example of a vision that has survived and grown despite the changing agendas of funding agencies and politicians, a vision of a centre where women can become confident users of technology. Above all, it has played a unique role as a place of personal change and transition for women, an inspiration for other community ICT initiatives, and has created a culture of women using and shaping technology.

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KEY TERMS

Cyborg: Originally used to describe human-machine hybrids and commonly found in science fiction, the term was adopted by Haraway (1991) to advocate women's involvement with rather than rejection of technology.

Digital Divide: The division between those who have access to ICTs (particularly the Internet) and those who do not, implying that those without access are disadvantaged. It is used to describe both local and global inequalities.

Electronic Village Hall: A centre providing computers and Internet access for local people or people from a particular community or group. It is also known as a cybercafe, community technology centre, telecentre, or telecottage.

Empowerment: Development of the capacity (either of an individual or a group) to act independently and be able to make and influence decisions and choices affecting one's own life.

ICTs (Information and Communication Technologies): The convergence of computerised information systems with communications technologies, generally used to mean all forms of electronic communication including computers, mobile phones, and other devices.

Information Society: A society in which information and knowledge are central to economic and social life, in contrast to industrial or agricultural societies. The term was widely used by British and European policy makers in the 1990s.

Liberal Feminism: Feminist theory focusing on equal rights and emphasising the removal of barriers to ensure equality of opportunity for all regardless of gender.

ENDNOTES

1 In February 2005, 35% of adults in the United Kingdom had never used the Internet. Of these, 42% had no Internet connection, and 37% felt they lacked the knowledge or confidence to use it. (Office of National Statistics, http://www.statistics.gov.uk)

2 For example, the UK Online initiative in 2000

3 The Office of National Statistics (http://www.statistics.gov.uk) estimated that 64% of men and 56% of women had used the Internet in the 3 months up to September 2005.

Cultural Factors and Collective Identity of Women in ICT

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INTRODUCTION

There is a considerable body of research to support the longstanding problem of a gender imbalance in the ICT industry (Ahuja, 2002; Baroudi & Igbaria, 1994; Cukier, Shortt, & Devine, 2002; D'agostini, 2003; Frenkel, 1991; Moody, Beise, Woszczynski, & Myers, 2003; Nielsen, von Hellens, & Wong, 2000; Nielsen, von Hellens, & Wong, 2001). However it appears there has been little attempt to draw it together to inform the influences and impacts that many women face when employed in the industry. The objective of this article is to examine research focussing on two factors that have impacted on the experiences of women who have established careers in the ICT industry.

GENDER IMBALANCE IN THE ICT INDUSTRY

The authors conducted a search of the literature related to gender imbalance in the ICT industry. From this, it became apparent that the existing body of literature consistently identified a number of elements as representing the existing state of ICT workplaces. It is possible and perhaps probable that some of these elements are conspiring to influence the:

1. *Cultural factors* typically encountered in ICT workplaces
2. *Collective identity* of women employed in ICT workplaces

Cultural Factors

In reviewing the gender related ICT literature, an image of the tensions that are at work and could influence and impact on women working within the industry emerges. These factors are, in general, subtle. However, they do make a contribution to enhancing understanding by highlighting potential relationships between social pressures to identify reasons and solutions relevant to the current situation within the industry.

Dominant Male Culture

The idea of ICT as a male dominated industry characterised by masculine language and modes of operation is evident from the literature (Pringle, Nielsen, von Hellens, Greenhill, & Parfitt, 2000; The Women in Science Engineering and Technology Advisory Group 1995). A sense of a shared masculine ownership of the science and technology sector as a whole pervades with the result women can feel marginalised and isolated. One outcome of this is a perception that senior men in industry favour males coming in and regard females almost with suspicion and even derision.

The notion of the IT sector as a male domain has conspired to perpetuate a culture of long working hours and masculine language. von Hellens, Nielsen and Trauth (2001) found that while many women did not see IT as an inherently male domain, they reported situations where they had been challenged as a consequence of their sex. In addition, it was noted that many women do leave IT workplaces if they are unable to deal satisfactorily with male domination. Those who remain can be subjected to inappropriate language, advances and stereotyping within the workplace (Teague, 2000; O'Neill & Walker, 2001).

Competitive Atmosphere

Women working in ICT are constantly confronted by the competitiveness of men in presenting themselves and promoting themselves. The preference of women for connections rather than competition may contribute to the levels of discomfort generated within the competitive environment (Lind, 2000). Men can be aggressive and arrogant in the way they compete and reluctant to admit making mistakes or not knowing something. Women tend to find this approach confronting and a challenge to their self-confidence. In general, they tend to have less confidence in their abilities and may be less likely to attempt new activities or activities that are considered challenging. This can have a detrimental effect as it often precludes women from opportunities to demonstrate themselves in a positive light in the work situation. Since these characteristics are valued within the male culture women are disadvantaged as a consequence (Teague, 2000; Cuny & Aspray, 2000).

Demographics of Women in IT within Organizations

As a group women working in ICT workplaces have less organizational tenure, less job tenure and are younger than their male colleagues. Few women hold senior management positions in the sector (Ahuja & Rodlain, 2000; Baroudi & Igbaria, 1994; O'Neill & Walker, 2001; Pringle et al., 2000; Trauth, Nielsen, & von Hellens, 2000). Results from the Association of Professional Engineers, Scientists, and Managers, Australia (APESMA, 2002) survey showed that in the Australian computer profession women outnumbered men in levels 1 and 2 of responsibility and that their representation began to decrease at levels 3 and 4 of responsibility. Further at the higher levels of responsibility (5 and above) men outnumbered women almost to the extent of two to one (APESMA, 2002). In addition often when women achieve seniority in job title this is not reflected in the opportunity to participate in critical IT decision making in the organization and team leadership (Panteli, Stack, & Ramsay, 1991). The exclusion of women from IT management ranks has implications for their career options and probability of better remuneration (Truman & Baroudi, 1994). The distribution of women throughout middle and lower levels in the industry is significant. Panteli, Stack, and Ramsay (1999) reported that even though they might share the same positional role and title as men, women are not engaged in the same projects. Women are more likely to be engaged in administrative functions (O'Neill & Walker, 2001) or in low status specialities such as merging and tidying databases (Pringle et al., 2000).

Effect of Gender Traits

From the literature, it has become apparent that some researchers have concluded that there are specific gender traits and that the existence of these traits impact on the manner in which women assimilate into ICT workplaces. Venkatesh and Morris (2000) explored gender traits in ICT and suggested that men were interested in how useful technology was while women were interested in how easy it was to use. Another gender trait they identified was that women, more so than men, are influenced by peers and others when making decisions to use technology. Women also have a greater need to belong to a group, a greater interest in personal goals and were more responsive to the needs and feelings of others.

For those women who have already chosen to work in ICT workplaces Holmes (1998) found that while men and women do not differ appreciably in relation to many of their work goals, men consider high earnings, variety and advancement as more important than women. Ahuja (2002) has suggested women make choices that see them placed in positions and professions considered female friendly and offers that this may be occurring because of the diversity of roles that women fulfil during their lives. Generally, women prefer a greater balance in their lives.

Balancing Work and Family Commitments

Many women successful in the ICT industry appear to have sacrificed family for work. Even where arrangements exist for women to access flexible working arrangements there is a tendency not to do so. Dowse and Underwood (2001) depicted a negative image for the future of the ICT industry for balancing work and family for both men and women. Historically ICT as an industry has not been sufficiently cognitive of the needs of employees trying to balance paid employment with raising a family (Pearl, Pollack, Riskin, Thomas, Wolf, & Wu, 1990; Truman & Baroudi, 1994). The image of the culture of ICT workplaces is one of long hours often worked outside of normal business hours. So enduring and pervasive has this view become that both men and women have come to expect this regime within ICT workplaces to the point where managers have been reported as rebuffing staff complaints about hours worked because that is just the way it is in IT (Nielsen, von Hellens & Wong, 2001, O'Neill & Walker, 2001). However, the long hours are biased against women (O'Neill & Walker, 2001). Women do shoulder a greater share of the parenting responsibility in most families (Dowse & Underwood, 2001) and because of this expectation it is likely to be a severely limiting factor for females in the ICT industry. To be successful in the industry, women typically need to prioritise work over family (Pringle et al., 2000) while others delay having children until later in life (APESMA, 2002).

ICT as a Solitary and Isolating Career

The image of ICT as a solitary and isolating career still endures. Women tend to favor personal interaction and communication and as a consequence a career that conjures up images of isolation and boredom may be perceived as unattractive (Nielsen, von Hellens & Wong, 2001, Trauth, 2002). The dominant image of the computer nerd is that he is incapable of interacting with people (von Hellens, Pringle, Nielsen, & Greenhill, 2000). Interviews conducted by Trauth (2002) with women working in the IT industry revealed that in order for them to be successful they needed to work alone. This is contrary to the need of women to openly communicate and engage in collaborative approaches (Panteli, Stack, & Ramsay, 1991).

Collective Identity

The second major category identified in the literature is based on examples of literature dealing specifically with the characteristics of women employed in ICT workplaces.

Exhibiting Masculine Tendencies

There is a strong sense within the existing literature that women who are successful working within ICT workplaces have a picture of themselves as being different to most women and more like men in some ways (von Hellens, Nielsen, & Trauth, 2001, Webb, 2002). The women interviewed by Trauth, Nielsen, and von Hellens (2000) who had achieved management positions agreed they have personality traits described as masculine. This happened to the extent that a women professor intentionally aligned herself with the sexist males in order to achieve a "shining career" (von Hellens, Nielsen, & Trauth, 2001).

Further, the women who have achieved in ICT workplaces tend to be more competitive and perhaps as a consequence they do not embrace stereotypical gender roles (APESMA, 2002; von Hellens, Nielsen & Trauth, 2001). They have described themselves as being logical, assertive and task-focussed (Nielsen, von Hellens & Wong, 2001). As one women recounted, to obtain a position in a particular IT organization she felt it necessary to prove that she could 'drink as many beers as the men' (Pringle et. al., 2000, p. 4).

Women Who Use Mentors Tend to be More Successful

There is a lack of mentors and mentoring opportunities for women. As a result many women coming into the industry are denied appropriate role models and the support from other women to whom they can relate (Sumner & Neiderman, 2004; Teague, 2000; von Hellens, Nielsen, & Beekhuyzen, 2004). The shortage of mentors is problematic as this support is crucial to provide positive work experiences in the IT industry and an ability to achieve career success (Pearl et al., 1990).

Ahuja and Rodlain (2000) found a likely connection between the success of women in IT, their intention to remain and advance within the field and the effectiveness of mentoring relationships. von Hellens et al. (2002) cited the example of a young IT professional who was fortunate to have a female team leader. This mentor supported her appointment as a project leader that enabled her to demonstrate her capability in the role and gain acceptance in the organization.

Capacity and Willingness to Adopt Adaptive Behaviours

In the ICT work environment, male personnel are established as the benchmark and women are often forced to adopt masculine behaviours to participate let alone succeed (O'Neill & Walker, 2001). From a constructivist viewpoint, Trauth (2002) states that while women are subject to different social influences, to succeed in the IT environment they need to adjust to work in a male dominated workplace.

From the literature there is an impression that adaptive behaviour may disadvantage a woman in the workplace (Nielsen, von Hellens, & Wong, 2000; Pringle et al., 2000). Pringle et al. (2000) have argued that it should be unnecessary for women to adapt because their organizational and communication skills can challenge the link between technology and masculinity in an IT environment. While this view may have merit the current literature lends little support for the success of women who cannot or will not adapt to the current ICT workplace paradigms.

DISCUSSION

The issues discussed in this article are not claimed to be representative of all actual situations in ICT workplaces. While these have emerged from the literature, it is acknowledged that examples of gender equality cultures do exist in the industry. However, there is ample evidence in the literature to support that generally there is a male dominated culture in the ICT industry.

Gender imbalance is a complex issue and often belies simple explanation and resolution. With respect to the ICT work environment it may be that this domination was established at the very origin of the industry, a time when technology was seen solely as a male activity. Potentially this set a foundation where the notion of homosocial reproduction has perpetuated the situation. Homosocial reproduction implies the politics of the dominant group in the organization will largely drive decisions and actions. While it is possible to change the male domination in the ICT work environment it will be a slow process and to be effective must be embraced by those within the industry. The major barrier is that change will not happen unless there are a sufficient number of women succeeding in ICT workplaces.

If the dominance of the male culture is not challenged, it is unlikely that change will occur. As long as male dominance remains it is central to maintaining the inequitable demographics of women in IT organizations, the competitive atmosphere, the problems of balancing work and family commitments and the solitary and isolating nature of careers in the industry. While there is evidence to support that gender traits can affect the work experiences of women, a change in culture may be more accommodating to the different attitudes and approaches between the sexes.

From a perspective of collective identity it becomes clear that women who do succeed in ICT are those who are willing to be adaptive and get on with their careers. While this tends to involve the adoption of masculine tendencies as a minority group it is probably the only way they can compete on an equal level.

CONCLUSION

The aim of this article was to present an examination of the literature that reports the impact of cultural factors and the influence of collective identity on women who have established careers in the ICT profession. In so doing, it has highlighted some of the issues that have confronted some of the women who have forged successful careers in ICT.

The benefit of this approach is that it offers information to enable women to be better prepared and informed when contemplating a career in the ICT industry. Perhaps this could prove instrumental in reducing the number of women leaving the industry because they are ill equipped to cope in a male dominated work environment. Potentially this may reduce the negative image of the industry. As such it may attract more women to consider careers in ICT and, at the same time, stem the high attrition of women from the industry.

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KEY TERMS

Collective Identity: Implies the characteristics exhibited by any group of people in specific circumstances.

Gender: The biological division of the sexes. This division does not consider psychological or other facets of the construct gender.

Gender Imbalance in ICT: The state in which there exists a significant difference between the percentage of male and female participation within the ICT industry. This imbalance extends across most levels of appointment within ICT workplaces.

Homosocial Reproduction: A process in which the politics of the dominant group in the organization will largely control decisions and actions.

ICT Careers: A general term associated with the ICT industry that covers a diversity of roles involving technology, information processing and people issues.

ICT Industry: A business sector focussed on supporting computer infrastructure, people, and information processes within and between organizations.

Organizational Culture: This refers to the shared values, characteristics and rules that govern behavior and attitudes in specific workplace environments. These may be formally or informally applied depending on the nature of the organization.

A Cultural Studies Approach to Gender and ICT

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INTRODUCTION

This article introduces a cultural studies approach to the field of gender and ICT. This implies an emphasis on the symbolic aspects of technology. Technologies are approached as cultural phenomena to which meaning is attached, but in the sense that they are open to various interpretations. Technology holds a position as a key symbol in Western societies. A key symbol is, in Sherry B. Ortner's terms, a symbol that helps us to sort out experiences and put them into place within cultural categories, and even help us think about "how it all hangs together" (Ortner, 1973, p. 1341). This key symbol has gone through a radical transformation from mechanical machines to ICTs as the leading technologies. An important question is how changing technologies are linked to another key symbol, namely that of gender. Moreover, following from that question, how can you study the relationship of gender and ICTs when both are continually changing?

THEORETICAL KNOTS

My own background is from a Norwegian network of researchers who have been studying gender and technology for the last 25 years. The differences between two Norwegian collected volumes may indicate a changing direction in the understanding of gender and ICT from the 1980s until today. The volume from the 1980s depicts technology as a tool of power in the hands of men (Lie et al., 1988). This provided a clear line of analysis as well as a direction for action to change the imbalance between men and women's access to technology. A volume from the 2000s, however, depicts a cybernetic pattern with threads and knots and loose ends—and may serve as an illustration of a seamless web with neither one distinct pattern nor one direction for change (Lie, 2003).

In our research during the 1980s, we analyzed technology as a means of power within a gendered division of labor. Technology was analyzed as the result of social constructions with in-built gender divisions, or in David Noble's terms, "frozen culture" (Noble, 1985). At the same time, however, technologies are also messengers, telling us who and what belongs where. During the 1990s, my focus shifted towards the symbolic dimensions of technology and the strong connections between technology and masculinity. As a symbol of masculinity, technology strengthens bonds between men and offers a way of "doing" or "performing" gender. To prove one's competence with technology is to prove one's place as a man among men. This perspective tends however, to be too static and has therefore spurred a search for new perspectives that include changing technologies as well as varying and constantly changing understandings of femininities and masculinities.

Within the field of gender and ICT, most attention has been accorded to women and how one might change their attitudes to technology. Feminists have tried to move away from this one-sided perspective towards regarding it in relational terms, thus drawing attention to technology as the other side of the gender-technology relationship. Instead of changing women, it was argued, one should change technology and the culture of technical institutions. In this way, however, both the concept of gender and that of technology may appear to be given and stable, thus in need of conscious strategies if they were to change. However, what we actually observe is that both are constantly changing. Suffice to mention how computers as calculating machines have been transformed into information and communication devices (Turkle, 1995) and continuing debates about what gender means and proper gender conducts. The challenge is that when we try to find out why gender still matters in relation to ICT, the themes we are dealing with tend to change their shape: gender relations are re-negotiated and new technologies appear. Thus, once we have identified a strategy to include women into the field of ICTs, the whole field is re-configured. Change is therefore obviously, what theories of gender and technology have to include.

Moreover, ICT is no longer an exotic item with the prefix cyber-, alluding to something that is virtual, out of the real world, and exclusively for a minority with access to a cyber society. Today, ICT indicates rather familiar items that are included in the everyday routines of many people, at work, for entertainment, and for social activities. ICT is part of a variety of activities related to different aspects of people's lives. However, we still tend to talk about ICT as if it were one thing.

As mentioned, the studies of gender and ICT have mainly directed the attention at women, and they are often focused on education (cf., Gansmo, 2004; Lagesen 2004). Women's attitudes and relationships to ICT have been studied empirically. It has been said that women's performances are measured against a norm that is set by men, and consequently women are considered to do computing in an inferior way and not up to standards (Corneliussen, 2003; Rasmussen & Håpnes, 1991). The difference is conceptualized in terms of men's more technical approach vs. women's more communicative approach; that is, men are deemed to be interested in and competent at technical matters whereas women are deemed to be interested in chatting and e-mail (Stuedahl, 1998). We may ask, however, whether this feature of "men as norm" does not actually refer to "real men," with varying user patterns, but rather to an abstract "ghost feature" of masculine gender symbolism.

Studies from working life have shown that when masculinity is symbolically linked to different technologies and to technical competence, it is the result of cultural practices (Cockburn, 1983, 1985; Faulkner, 2000; Lie, 1998; Mellström, 2003; Wajcman, 1991). The symbolic association of technology and masculinity is, in other words, not self-evident but must be produced and confirmed continually. This also tells us that gender symbolism is open to change, holding that matters do not "have" meaning but are accorded meaning by actors and within particular contexts (Geertz, 1973). My concern is how gender functions as a cultural distinction that literally "gives" meaning to technical artefacts and practices.

TECHNOLOGY AS CULTURE

A cultural studies approach to the knot of gender and ICT implies that not only gender but also technology is analyzed as a cultural phenomenon. Technology and culture are conceptualized as interwoven in mutual shaping processes. This mutual shaping can be studied in design and also during the cultural consumption of a new technology. In Norway, a user perspective and focus on cultural appropriation of technology have been prominent in gender and technology research (Berg, 1996; Lie & Sørensen, 1996). This is an approach following the traditions of social shaping or social construction of technology (Bijker & Law, 1992; MacKenzie & Wajcman, 1985;), the point being that a technical device could always have been otherwise. There is no technical necessity that leads to a certain end product, and culture is integrated, literally in-built, in the technical products. Moreover, the concepts of gender and ICT cannot be explored separately because they are intricately interwoven. This implies leaning on the metaphor of a seamless web of technology, culture, and society (Hughes, 1988) and on cyborgian and hybrid conceptualizations that blur the otherwise clear boundaries between nature-culture, both in the sense of sex-gender and human-technical (Haraway, 1991, 1997).

The connection of technology to masculinity has implied that tools are more easily identified as technologies when they belong to the masculine realm, whereas tools associated with women are more ambiguous and may be categorized otherwise, as with kitchenware or sewing-kits for instance. In this way, preconceptions regarding gender are constitutive for what is recognized as technology. Likewise, with technical competence as a characteristic of masculinity, technology has functioned as a device for sorting out gender. Although we recognize a variety of masculinities, meaning that there are many ways to be identified as "masculine", a close relationship to technology still remains one of them. However, whereas steel, cogs, and mechanical machinery produced masculine connotations related to muscles and strength, computers are more ambiguous. This ambiguity refers not only to the design of machinery but also to the varied social contexts of ICT use. Thus, the new ICTs could have meant a re- or de-gendering of technology, but the social processes taking place have directed ICTs towards traditionally masculine realms. One example is the linking of computer science to technical institutions; another is the production of software for "boys' games" (Cassell & Jenkins, 1998). But—it might have been otherwise. The rapid introduction of computers into a wide variety of contexts is contributing to the opposite effect of de-gendering ICTs.

GENDER AS "PRODUCER OF MEANING"

Here, gender is considered as cultural distinctions that are activated to literally "give" meaning to technical artefacts and practices related to them (and vice versa). The cultural categories of masculine and feminine may or may not be in accordance with what particular men and women look like and act like. Since the notions of femininity and masculinity are basic categories of distinction, though culturally specific, gender is a relevant category when technologies are designed, advertised, talked about—in other words, during all stages of a technology's "life cycle."

The design of technical artefacts is based upon imagined users and it may make a difference whether the projected users are imagined as men or women. The visions of designers are inscribed in the products, in the sense that "like a film script, technical objects define a framework of action together with the actors and the space in which they are supposed to act" (Akrich, 1992, p. 208). Such scripts can be deduced from the technical products, and differences that habitually are recognized as feminine and masculine may be identified in the design (Berg & Lie, 1995; Oudshoorn, Sætnan, & Lie, 2001; Rommes, 2002). Designing computer games, for instance, the imagined user is generally a young man, and designers emphasize that what they are after is "a good story"—but not reflecting on the combination of the two statements (Gansmo, Nordli, & Sørensen, forthcoming). Still, the combat heroines like Lara Croft are not only men's "perfect fantasy girl" but also an ambiguous mixture of male and female.

The design of technologies is, however, only one step in the process of its cultural construction. Even after a piece of technology has assumed a particular form, it still retains interpretive flexibility. Through the media, we get information on what this particular technology is meant to be, why it is important, and what it is useful for. We get other versions via product marketing and through education and information materials. These are ways in which technologies are domesticated within a particular cultural context. Users contribute to the process of domestication when they are adjusting technologies to their own needs and lifestyles; in other words "taming" them when bringing them home (Lie & Sørensen, 1996; Oudshoorn & Pinch, 2003). This is because technologies have to be enculturated in order to function, thus users must accord them meaning and fit them into their lives. Through domestication processes, new technologies are fashioned to users' daily lives and routines, which in turn are adjusted in relation to the new technologies. Domestication also involves the discussion and demonstration of technologies amongst users. An obvious example is how mobile telephones and PCs have become so visible in our daily lives, and how widely and enthusiastically the use of these objects is discussed and interpreted in everyday conversations.

In the cultural process of defining what ICT is, how it should be used, what ICT skills are, or in other words what "counts" as valuable knowledge and skills, gender functions as a cultural category in sorting things out. In this process of negotiating boundaries, gender is a marker that still functions to sort out high tech from low tech or no tech. The mobile phone, for instance, changed rapidly from a rather exclusive high-tech gadget to being for everyone. We might reason that the gender of the users affected the image of the artifact, as did the young age of the users, in the sense that when women and youngsters were identified as users, it became trivial. With PCs, chatting is often designated as a girlish activity, even if many boys, as well as adults, are active chatters; whereas gaming is held as "a boy thing", thus making girl gamers invisible (Nordli, 2003). In such ways, new technologies spur processes of boundary work and renegotiations of what is to be considered masculine and feminine.

The concepts applied and the examples given, serve to illustrate the point that neither technology nor gender should be taken for granted. Rather technologies should be studied as artefacts and types of knowledge that are shaped by cultural processes, not only while the technology is being developed and produced, but also by its subsequent use and reputation. Whether a particular technology is considered interesting and accessible or not, is dependent not only on how it is designed, but also on how it is presented to users and interpreted by them. At the same time, gender and gender relations are designed as relational to the different designs of technologies. So gender is not "given" in the sense that it consists of respectively male and female capacities and fields of interest that do or do not fit with technical artefacts and technical skills. What we need to study are processes of gendering (i.e. how gender transfers meaning to artefacts, practices, and places); the negotiations taking place when ICTs are introduced into new contexts or for new audiences; and the flexible interpretations of gender and technology in such cases.

To take an example: when young teenage girls together talk about computers as something nerdy (Håpnes & Rasmussen, 2003), they tell each other that this is something that we do not need to know anything about: we can ignore it, or, if we want to use it, we should under-communicate the use of it. Accordingly, ICT has a masculine label with negative connotations in a particular age group within which strong gender dichotomies prevail. Still, if a girl is good at it, she may be admired and not considered "nerdy" or masculine because of this interest. The nerd image is available but does not have to be used in a particular context. Moreover, such notions are flexible. Nerd may be used as a negative label, but at the same time some people like to use it, meaning to express that they actually spend a lot of time at computers and therefore possess wide expertise within the field. Likewise, the notion of the hacker has a double meaning, or maybe even triple: a "person without a life," super expert, or burglar/outcast. Again, several meanings are available as a repertoire one can draw upon. The nerd image is one, but that does not mean that the computer and its users are pinned down once and for all, as nerdy and only that, because there is always interpretative flexibility in cultural matters.

FUTURE PERSPECTIVES

One important change of gendered relations to ICTs is that women are increasingly participating as users. In this sense, ICTs are not linked to masculinity as an exclusive male domain. This trend also contributes to a de-mystification of the field—it is not only for nerdy insiders; rather, it is a technology for everybody. When it comes to developments within the ICT branch, however, this is still dominated by men, and we should therefore be aware of new "divisions within."

Lagesen (2003) has studied campaigns to attract more women students to computer science whereby one tries to redefine it as a "feminine subject" by stressing the aspect of communication. Lagesen points out that there may be a new trend not simply identifying ICT with masculinity, but towards a division whereby one tries to attract men by emphasizing the T, and detached from I&C, which are advertised as interesting for women.

We may be aware of such cases of re-gendering based on gender dichotomies. Still, I would like to draw attention to how cultural processes of gendering new matters also can take different and unexpected paths. There are a wide variety of possible cultural interpretations. Thus, it is not a good idea to take as a point of departure, that ICT is a masculine matter and ask how we can change that, but rather to seek out other issues from the wider cultural repertoire that can be associated with ICTs.

CONCLUSION

Is it possible to modify the cultural associations of gender and ICT?

Firstly, gender is more than differences between women and men. Gender is also a cultural distinction that provides us with categories that are applied to produce meaning. We literally use gender as a tool to identify ourselves, to identify people we relate to, but also to identify practices, events, and new artefacts. To "give" things gender is to put them into place, like when talking about computers as for instance nerdy/masculine or useful/feminine. We may instead talk about them as exciting and eventful and stress that they are multi-facetted—in other words, strive to attach to to them a wider repertoire of meaning that is not one-sidedly gendered.

Secondly, this leads to the question of change in relation to cultural matters. The problem with culture is that it is the very material we are thinking with.

Therefore, it is difficult to deliberately make a change and think differently. Still, there is some variety in the cultural images connected to ICT. What we should be aiming for is to utilize this variety and also to expand the repertoire. We may acknowledge and speak about ICT as a field that includes much more than male nerds and hackers. More attention should be directed at cases where women are active users and designers and where women use ICTs in unexpected ways. Even if these are not the "majority cases," they are important within a strategy for developing new perspectives on gender and ICT.

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KEY TERMS

Boundary Work: Intentional and unintentional efforts to maintain gender divisions.

Domestication: The cultural appropriation of technology.

Gender Dichotomies: Feminine/femininity is defined in terms of being the opposite of masculine/masculinity and vice versa.

Gender Script: Gendered connotations are in-built in the design of a technology.

Gender Symbolism: Cultural associations of masculinity and femininity.

Key Symbol: A symbol that summarises main features of a certain time within a particular cultural context.

Script: Directions for use integrated within the design of a technology.

Cyber/Ecofeminism

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INTRODUCTION

Cyber/ecofeminism is a holistic concept that I have coined and adopted to approach the burning issues of information technology, women's studies, and the women's movement in the age of globalization. It serves as an ethno- and gender-sensitive compass towards eco-social sustainability in an era where technology has an increasing impact on all aspects of life. In order to resist the Master identity that women, along with men, risk embracing, as they get plugged, downloaded, and wired into the digital world, one needs to introduce alternatives to the models of "compulsory heteronormativity," dichotomous and hierarchical sex/gender systems, as well as dysfunctional, exploitative animal/human relations. The dominant worldview is a world of "bits" and pieces—fragmented, atomistic, and hierarchical. It echoes in this like the hidden gender contract with its binary structure, segregation and splitting of male rationality of production and female care and emotional labor. Cyber/ecofeminism is my method and approach also for exploring which of the schools—cyberfeminism OR ecofeminism—promises more hope for a woman-friendly, ecologically, economically, socially, and culturally stable and sustainable future.

ECOFEMINISM

Françoise d'Eaubonne first invented and used the term ecofeminism in Le Féminisme ou la mort (1989). Ecofeminism has since then been associated with the premise that in global patriarchal practices, women, animals and nature share a subordinate and instrumental relationship to hegemonic, mainstream, and dominant men. The s/exploitive attitude is rooted in the Western epistemic tendency to separate feelings and care work as the domain of the subordinate class (particularly women) from reason and productive "rationality," the domain of men and mostly white elites. Denial of feeling-based knowledge and empathy enhances the ability to distance oneself from objects both of research and economic profit—a precondition for the kind of "rationality" that ignores the global ethics of care, belonging, and responsibility. Furthermore, underprivileged groups are subject to patterns, attitudes, and institutions of male domination and control that tend to also be gendered "feminine" as one of the means of that control in many parts of the world. Ecofeminists (for all their differences) see humans as integral components of the ecosystem, not separate or superior. Yet another key principle is the importance of non-hierarchical systems which follows from the holistic emphasis on interdependence and which leads to the complementarity and equal status of all parts of the ecosystem (Davies, 1988, p. 5; Merchant, 1992, pp. 76-78; Longenecker, 1997) argues that our notions of nature and ourselves change qualitatively if we imagine nature, not just humans, as subjects. It is much easier to exploit and abuse entities not perceived as having a soul, whatever "soul" or "spirit" evokes for modern people. A mechanistic interpretation of the surrounding cosmos is likely to lead to commodification of animals and vulnerable groups and serves ecologically short-term interests. Ancient pre-patriarchal gift economies in all their variety (Kailo, 2000, 2004a, 2005a, 2005b) were based on a worldview that was more conducive to mutually respectful and grateful human/animal relations because of the recognition of interspecies interdependency and the core value of life renewal rather than resource extraction: "In practical terms, hunter-gatherers would have to be the affluent societies par excellence. They are self-sufficient and thus genuinely autonomous. They have a stable interchange with their habitat, they use low-impact technologies—they work only a few hours a day, and give energies to social bonds, ceremony and art. Ecologists taking a lesson from Aboriginal cultures might discover how to devise low—demand, low-impact economies where sustainability and social equity can go together … (Salleh, l997, p. l30). Western industrial and patriarchal cultures have much to learn from "pan-indian" ecologically sustainable philosophies and worldviews in all their diversity although individual members of Native nations do not always practice what their cultural traditions promote.

CYBERFEMINISM

One of the perceived strengths of cyberfeminism is that it presents women with an optimistic alternative to theoretical positions that relegate women to the status of victims or glorified mothers within a context of a vilified omnipresent patriarchy. By focusing on women's abilities and contributions, cyberfeminist perspectives resist reproducing patriarchal constructions of women as technologically incompetent who cannot be wired into technology. Such views are influenced by post- modern theories, and owe much to the widely cited "Manifesto for Cyborgs" by Donna Haraway (1991). Haraway's article is an effort to displace traditional dualisms that associate women with nature and men with culture and technology. She does this through the cyborg seen as providing a theoretical way out of common western gender relations and representations. The cyborg is presented as breaking down the division between the artificial and the natural because this distinction is no longer practical in modern technological society. For Haraway, woman is the representation, no longer of marginality, otherness, objecthood, but of the middle ground between humans and machines, the virtual hybrid creatures that everyone is supposedly becoming: "A cyborg is … a hybrid of machine and organism, a creature of social reality as well as a creature of fiction" (Kemp, 1997, p. 480). One important route for reconstructing socialist-feminist politics is through theory and practice addressed to the social relations of science and technology, including crucially the systems of myth and meanings structuring our imaginations. She concludes the manifesto with her famous statement: "Although both are bound in the spiral dance, I would rather be a cyborg than a goddess" (Haraway in Kemp, 1997, p. 482). Perhaps the best-known ecofeminist, Vandana Shiva retorts to her in Stolen Harvests. The Hijacking of the Global Food Supply (2000, p. 75) "I would rather be a sacred cow than a mad cow," underscoring the optimism of cyberfeminists, and referring to the downside of cyberprogress—its links with economic greed and the devastating manipulations of unsustainable agribusiness. Sadie Plant also believes that the Internet is triggering most promising debates about gender, race, ethnicity, and class because its users have new possibilities now to act without revealing these variables of identity. Finally, women's condition as the other is becoming that of men: "To become the cyborg, to put on the seductive and dangerous cybernetic space like a garment, is to put on the female. If the male human is the only human, the female cyborg is the only cyborg" (Plant, in Kemp, 1997, p. 506). Plant shares in the optimism of a digital age where women so to speak come to their own as web spinners and spider women—arts needed to surf the waves of the digital age (Kailo, 2002a).

Gift circulating archaic societies honoring women, animals, and nature through ritual drama are some counter-patriarchal areas of ecofeminist research. Their "gift logic" valorizes meeting everyone's social needs and creating the conditions of basic abundance for all. Cyberfeminisms focus more on the ways in which humans and machines are intertwined and the opportunities opened up by women's integration into the technology-led information society. Although ecofeminists seek to extend an ethic of care and eco-social responsibility to boys and men, not glorifying girls and women as "the angels in the ecosystem" they have been accused of consolidating the stereotype of women's closeness to women and animals. Cyberfeminists have been more motivated to sever this connection. They have not always considered that ecofeminists' key point often is the failure of men to embrace the eco-social values labeled as "feminine." They have been delegated as the duty and realm primarily of women—something feminists feel must be changed if the brave new information society is to become a just and healthy world for all.

COMBINING ECOFEMINISM AND CYBERFEMINISM

On the basis of my research regarding the eco-social impact of neo-liberal globalization, I have grown more skeptical of the promise presented by the cyber revolution for gender equality. I have had opportunities to participate at the events of an international alliance—Feminists for the Gift Economy—and to share views and strategies on ways of exposing, questioning, and transforming the competitive and short-sighted neo-liberal agenda. Among others, Vandana Shiva (1997, 2000)and Zillah Eisenstein (1998) have produced research and counter-patriarchal perspectives on global values that have a sobering effect on any excessive cyberoptimism as regards improvements to women's local/global status. Eisenstein (1998) cites numerous statistics and studies, which reveal the darker side of digital culture. Not only has the great advance in information technology and communications led to increasing gender-based injustices, but it has created the world-wide-wedge across many divisions, the leading Western industrialized countries and the developing countries in Africa and Asia, the intersections of gender, class, geography, age, ability, and religion being additional factors to consider. Under neo-liberal governments, decision-makers are providing businesses with unprecedented financial support (tax-payer money), which they spend on technological innovations that reduce the need for manpower, thus enhancing unemployment, automatization and accumulation of profit and power for wealthy corporations. Statistics and research (e.g., Ngan-Ling, 2003; Wichterich, 1998) reveal that across the developed and overexploited world, women serve as the class of cheap and flexible labour that allows the male-dominated fields to enhance their competitive edge—by outsourcing costs and employees to countries with weaker labour and environmental regulations. Women benefit from globalization thanks to the numerous new labour opportunities—however, they are often in sweatshops and involve miserable working conditions. Women's domestic and work-life flexibilities (low-paid or unpaid care work) are as surplus labor a kind of forced gift to the capitalist market economy. We must not forget what has always accompanied technological advances: instead of narrowing, they have tended to deepen the gap between the haves and have-nots, most of whom are women. Information society is also giving women—particularly elderly and poor women of the developing world—the shorter end of the (joy)stick. Eisenstein lists the amount of tax breaks given to corporations and wealthy individuals in l996 as US 440 billion, more than seventeen times the combined cost of state and federal spending on AFDC (Aid to Families with Dependent Children) (Eisenstein, l998, p. 62).

Technology and information society benefit greatly from women's ways of building community. I propose cyber/ecofeminism as a marriage of the two feminist schools (eco- and cyberfeminism) and as a self-reflexive method/worldview seeking to ensure that as feminists, we do not reproduce the hierarchical dualisms and controlling stance of the master imaginary. To be an ecofeminist need not, and often does not mean being technophobic, deluded or bent on mytho-pathetic reverse sexisms. It is not the technologies that alone wreak havoc anymore than it is nature that guarantees bliss and organic autonomy. It is the attitudes, ethos and values that humans bring to both that alone guarantee integrated, affective, and solidarity-oriented ways of being in the world, of sustaining the future in ecologically, culturally and ethno-politically sound ways.

Ecofeminist interest in peaceful, just societies and "matriarchal values" is not deluded and irrational as cyberfeminists have assumed. Archaic cultures contain much of the ecological and communal values that are needed in order to transform the dysfunctional profit-focused world of today. They provide blueprints for denaturalizing today's dominant assumptions according to which self-interest and greed, as well as the competitive impulse are the best guarantors of collective prosperity, economic growth, and social wellness. I call the totality of counter-hegemonic, need rather than profit-oriented strategies, approaches, ways of relating and circulating care the Gift Imaginary (Kailo 2004a, 2005a). One of its Internet applications could be the free software and other non-market-oriented gifts meant to make information technology—its material and immaterial innovations—accessible to all. We have to make sure that cyberpower is distributed and shared in an equitable manner between all of the "stakeholders" of the earth. Alternative non-dualistic imagery—adapted to modern times rather than romanticized—may well be found in prehistoric societies, but also in our current eco-social imaginary. Still, our modern imaginations are colonized and imbued with ecologically questionable models of consumerism and a media-run rat race or musical chairs. Gift and Give back economies provide a mind-altering example of a system based on global care, one based on circulating common gifts to those in need, and not only as part of (asymmetrical) exchange (Vaughan, l997, 2004). We need them to counter the unholy alliance of concentrated multinational power conglomerates and technological innovations supporting citizen surveillance and militarism done often at the expense of an ecologically and socially healthy planet. We also need counter-hegemonic representations of gender and gender relations that might contribute to men also identifying more with other-oriented gift circulation and solidarity work. As more and more women enter the male-dominated fields of IT and economics with their often competitive and ego-oriented market values, more of the care work needs to be shared equally by men and women. Women must no longer be made the exclusive embodiments and providers of emotional and domestic labor or those meeting the needs of children, the sick, and elderly. As women are becoming more like men, men must become more like women. Both need to adopt a healthy and ethical relationship with the "other," including the environment, as the precondition of an ecologically and societally sustainable future.

The widely-spread cross-cultural stories of women finding refuge from patriarchy in the bosom of nature with Bear are examples of archaic representations of human/animal relations that defy the hierarchical, dualistic tenets of the master imaginary. As transmitters of ecospiritual principles and embodiments of inner power, they are counter-mythologies that contrast with the dominant anthropocentric heroic myths. In these gynocentric myths women are are not defined in relation to male desire, as currency of exchange and exploitation. Women also need images of their power and multidimensional human possibilities beyond the whore/Madonna dualism or the gender equality discourse aimed at merely turning women into "honorary males." The woman/bear stories displace and challenge many of the taken-for-granted dualisms of Western identity: human-animal, dead-alive, male-female. From today's perspective, such alliances linked with "primitive" eco-socially sustainable economics mixed with spiritual beliefs are transgressive of the strict gender scripts and other norms of sex, culture, nature, and species (Kailo 2001a, 2002b, 2006a). Neither a reversal of Western dualisms, nor a mystical marriage of opposites, these stories are examples of a representation of human social organization as an eco-social pact that seeks to ensure the reproduction of nature's cycles, of proper human-human and human-animal relations. It is worth recuperating the images that present alternatives to the super-segregated gender roles resurrected by WIRED and other elite male magazines. As we seek to resist the politics of cyberporn and violence, we need representations of hybridity as a symbol of intersubjectivity and equality, not as a mere postmodern game of gender performance in a world of unchanged power relations. Beyond the marriage of machinery, technology, and gender, we need role models of ethical belonging and examples of peaceful societies to show that aggression and fierce other-denigrating and trampling competitiveness are not a universal norm (Miedzian, l991). We need also cybergoddesses with a difference: not as decorative and sexy objects, consumerist gifts for the male gaze, but as tokens of another scene, also of and for women of colour, poor women, women and men out to nurture the eco-social sustainable future of each other, and of the planet.

CONCLUSION

Cyber/ecofeminism as the combined appropriation of modern technology and ancient eco-social ethics of belonging is thus a creative paradox and a provocative means of riding the rapids of digital modernity, while ensuring the necessary politicization of the latest cyberfeminist wave. Technology does not create equality—power-sharing and a more fair redistribution of the world's resources in the concrete realm of politics and decision-making alone can accomplish that. Cyberspace is yet another male bastion, wired to keep feminists and other less powerful groups out. While I thus advocate hactivism—using cyberspace ethically, creatively and efficiently for networking in the name of global justice—I also advocate adopting the worldview based on the gift logic beyond the utilitarian master imaginary. Cyber/ecofeminism is a dance across the tight rope wires of patriarchal technology and the nature that supports them, a juggling act to challenge in-vitro-feminism. We do not benefit from virtual justice or virtual equality. We need concrete politics of affinity, eco-social justice and balance, here-and-now. The group—Feminists for a Gift Economy—sharing views on a Gross Nurturing Product, not the woman-exclusive GNP—is just one international pro-democracy alliance that is seeking to create another possible world—based on fair trade, fair technology, and equal opportunities for radically transforming the masculated (Vaughan, l997, 2004) world.

These are the values that guide me in my ongoing research on the gender impact of neo-liberal globalization and information society.

AUTHOR'S NOTE

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KEY TERMS

Cyber/Ecofeminism: A holistic method and approach for exploring the positive and progressive ways in which two feminist trends—cyber and ecofeminism—can be combined to enhance an eco-social sustainable future with equality and collective wellness as its pivot. Cyber/ecofeminism is proposed as a third term and concept to bridge the best of both schools of thought which are often perceived as each other's opposites (Kailo, 2003b).

Cyborg: "A cyborg is a cybernetic organism, a hybrid of machine and organism, a creature of social reality as well as a creature of fiction" (Haraway, 1991).

Ecofeminism: Associated with the premise that in global patriarchal practices, women, animals, and nature share a subordinate and instrumental relationship to hegemonic, mainstream and dominant men. The diversity among ecofeminists is as desirable and intentional as the diversity they promote and advance as a rewarding value in the biosphere and among human cultures themselves (D'Eaubonne, 1980).

Design and Women's Expectations of WWW Experience

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INTRODUCTION

Development of the World Wide Web (WWW) prompted a flurry of research investigating women's participation in the creation, production, and use of online technologies. Initial studies focused on trends in female users' participation rather than investigating the role of design in these processes (Pattanaik, 1999). Web design practice was rarely a focus. This article presents findings from my PhD research, which applies feminist and design theory to critique Web design. Focusing on a commercial UK based women's portal, BEME.com, I examine the value of Web design practice to female users and their expectations of online interaction. I describe the type of experience BEME.com intended for its female users, as outlined by the design team during interviews. Interviews with the production team were conducted two years after the design was completed, making them reflective in nature. Alongside interviews with the intended target audience, the aim is to highlight disparities between design intentions and female users' expectations.

BACKGROUND

Encouraging the discipline to review its position on gender and design, Buckley (1989) argued that design is implicated in maintaining patriarchal power relations. She warns that "female stereotypes [materialised in design practice] delineate certain modes of behaviour as being appropriate for women." (p. 252) Similarly, Whiteley, (1993) says "market-led design" represents … women in a sexist way, and … disregards women as end-users" (p. 137). Buckley (1989) observes that "[t]hese stereotypes have had enormous impact on the physical spaces "… which women occupy their occupations, and their relationship with design" (p. 252). On the other hand, Forty (1986) maintains that design practice offers a paradox where design practitioners are in charge of what they do and yet they are also willing or unwitting agents of ideology. Julier (2000) observes design practice role in defining consumption, making it active and passive, meaningful and meaningless all at the same time. He highlights design practice involvement in "… refining and controlling … patterns of meaning which pass from production to consumption" (p. 64).

Matlow (1999) advocates that new technologies are symptomatic of a paradigm shift from "modernist graphic design towards [a] fragmented postmodern approach." (in Warwick, 1999, p. 15); a shift illustrated by "… movement away from rigid structures and principles to the transparent and ephemeral which exists for the most part within virtual dimensions." (Warwick, 1999, p. 15) Matlow (1999) believes that this shift in relation to gender "… can illuminate professional and individual [design] practice" (in Warwick, 1999, p. 15). Thus, I argue, the relationship between gender and design within the context of the WWW is at a crossroads. On one hand, research has highlighted the conservative gendered approach to design for the WWW (Martinson, Schwartz, & Vaughan, 2002). On the other hand, the opportunity is ripe to investigate alternative ways to tackle gender (Spilker & Sørensen, 2000). There is a particular need to "… [assess] the deliberate, accidental, and alternative technological decisions and design-processes which, when implemented, form the interface between the network and its users" seeking "… to offer more complex, more problematized findings" (Silver, 2000, p. 24-25). Such an approach allows this study to go beyond mere description of the WWW and investigate the relationship between gender and design practice within an online context.

The BEME.com case study provides the opportunity to examine a portal developed directly from the women's magazine publishing tradition. A product of publishing company IPC Media (UK), which specialises in what are referred to as traditional women's magazines (including Marie Claire and Woman's Own). Its development in 1999 responds to an online industries boom at the end of the 1990s. The life-span of BEME.com—with its launch in 2000 and its closure only a year later—partially reflects the fortunes of Internet businesses more generally which, following initial commercialisation is threatened by economic collapse in 2001. The way in which the site design responds to these circumstances is revealing of the relationship between design processes, gender ideologies, and the commercial context.

The original design of BEME.com is slick, uncluttered, and thematically structured with a vertical layout, distinguishing it from other women's portals. The content and editorially driven BEME.com "brand" is given priority over an e-commerce led strategy. However, at the beginning of 2001, limited commercial success triggers a redesign strengthening its connection to paper magazines and to other women's portals. When this redesign does not generate sufficient advertising revenue and the site closed in August 2001. Its demise is attributed to its relatively late emergence in the dot-com boom as well as to the question of whether an editorially driven niche portal is the best way to attract female users. That notwithstanding, BEME.com is a site where ideologies, history and tradition materialise in the design process and artefact. Disparities between the intentions of the design team for the site and expectations of female users alert us to the issues affecting design attempting to reconcile a critical agenda with both gender structures and commercial imperatives.

INTENTIONS OF DESIGN TEAM

The intentions of the site, as expressed by the design team, fall into four main categories: corporate, visual, emotional, and women-focused intentions.

Corporate Intentions

Corporate Intentions relate to the public side of BEME.com—the aim to construct a unique brand. The male brand designer recalled that the best way to respond to today's online female user was to recognise her multifaceted identity. Hence, the intended "BE ME" experience was driven by the notion of "AND" or "BOTH" rather than an approach where readers subscribe to "ONE" ideal like the "Cosmo girl" or the "ELLE woman."

Nonetheless, corporate intentions were based on interpretations of what was already available for female users and what was on offer was based on interpretations of existing gender structures and stereotypes (Beetham, 1996). However, BEME.com did not put forward a straightforward interpretation of gender but offered a contradictory mixture of approaches. For example, the female editorial/creative director describes female users as both "…pathetic and clever, funny and serious, gorgeous and beastly, silly and thoughtful, glamorous and insecure" (D-CP1, l. 18-24). In her interview, she insisted that BEME.com's design was based on non-stereotypical representations of female users. While one could argue that her mention of "pathetic *and* clever, funny *and* serious ..." is anti-stereotypical. A radical feminist analysis also criticises the notion of "and" or "both", insofar as women are not only *allowed* but are *expected* to be both pathetic and clever, assertive, and submissive, women, mothers, wives *and* lovers; in other words, whatever patriarchy demands. Therefore, an attempt to absorb a feminist critique of gender often resulted in its dilution (Winship, 2002, p. 37). My research suggests that BEME.com's corporate intentions perpetuated the contradictory values (Ballaster, Beetham, Frazer, & Hebron, 1991) that have for 200 years secured commercial profit for the women's magazine publishing industry.

Visual Intentions

For BEME.com to sustain interest, the site needed to bring together interesting and relevant content, which meant a complex multi-level portal design. The male brand designer believed that this complexity required it to be intuitive and simple, with enjoyable layouts made relevant to female users by focusing on their daily lives (examples of which are unfortunately unavailable due to the site's closure). The visual language aimed to offer new, snappy, and easily accessible experiences with expandable content. Technological innovations of the WWW demanded that BEME.com be experienced through active participation rather then just observation. BEME.com's emphasis on one-to-one communication aimed to mirror the individuality of female users. However, these empowering ideas were undermined by ambiguous messages regarding gender structures. In descriptions offered by the designers, reference was made to employing alternative graphic norms, which, for their novelty in design for women, paradoxically revealed, the stereotypical norms informing BEME.com's design. Graphic norms that were described as inappropriate also indicate the particular gender ideology informing the design process. For example, the male brand designer observed, "[the] type that we used [for BEME.com logo] is what they use for motorway signs in the United States. So it's … quite bold and in your face ... which you wouldn't normally associate with … women's ... stuff." (I-PT4, l. 191-195) He goes on to state, "... [the letters used for the logo] really work .. they don't look hard and they don't look … aggressive. ... it just really works because it's bold and it's confident" (I-PT4, l. 198-200). An underlying gendered approach was criticised by the female senior producer. Not certain that women's portals should necessarily be feminist, she pointed out a lack of female designers on the production team, adding "… the actual concepting and design was not female at all. … as far as the [design] process goes, it's the same." (I-PT5, l. 285-287) This suggests that in her view, more women in decision-making positions would have resulted in a *different*, if not feminist approach. As Rommes (2002) argues, it is not enough to have female members as part of the production team. Gender structures affecting the design process have to be addressed.

Emotional Intentions

Emotional Intentions informed the design team's efforts to inspire brand loyalty. The male design manager/designer believed that loyalty would result from offering personalised experiences. The production team insisted that interaction with the site had to be enjoyable and only then would female users continue to visit and endorse the site.

Women-Focused Intentions

Women-Focused Intentions addressed the specificity of the target audience. The female senior producer associated women-focused intentions with the notion of an online female community. Women-focused intentions meant recognising the value of the target audience as intelligent, complete individuals. She endorsed a strategy "… to get women talking about BEME and talking to each other … to keep them there and to keep them in the community aspects …" (I-PT5, l. 346-349). She was the only member of the team who questioned female online users' association with gendered assumptions.

EXPECTATIONS OF TARGETED FEMALE USERS

Hawthorne and Klein (1999) emphasise the importance of women's participation in the development and regulation of Internet technologies. As Reitsma, Reeve, and de Regt (2000) argue, the commercial world conceives of women's involvement in terms of consumption and spending, the research has revealed female users' engagement with the WWW to be far more complex.

A yearly market survey monitoring the British population's response to the Internet indicates that users see the WWW primarily as a resource supporting their e-mail, education, research, and/or information seeking (which?online, 2002). Female users interviewed in my research were mainly concerned with its practical capabilities, as a tool where "purpose" and "access" were important. The "visual" factor was not of great value to the female users; unless it infringed on access, they expressed little interest in changing online content design. They saw BEME.com as a finished design outcome without possibility of adjustment, an irony in light of the fact that it is easier to alter online than print media.

How female participants saw themselves as online users was associated with the "emotion" factor; the types of experiences individual users have had and the construction of their identities. At the present time, being knowledgeable about new technologies is just as important as other aspects of identity construction: "... the WWW is now seen more than ever as a fundamental part of 21st century living" (which?online, 2002). Therefore, "keeping up with progress" was another factor informing female participants' constructions of themselves and it was this belief that linked female users' purposeful application of the WWW to their understanding of themselves as online users. Of particular interest was female users' lack of concern about how they might be perceived by others as consumers of the WWW. My research suggests that female users saw themselves as part of a social collective, offline and online, neither of which infringed on their strong sense of individuality.

Although BEME.com claimed to promote individualised experience, it classified users by their gender. Feminist scholars have problematised commercial application of the WWW where female users are seen as a gendered niche market addressed in one voice (Crow, 1997; Paasonen, 2002). Similarly, the interviewed female users did not see themselves defined only by gender. They felt they knew what they wanted from the WWW and that others either shared those notions or were aware of them. However, this was not reflected in the "women-focused" understanding promoted by the female senior producer of BEME.com. Rather, the interviewed female users echoed the female editorial/creative director who endorsed the idea of recognising women as individuals with a strong sense of self and consumer choice.

In summary, BEME.com generated a set of social interactions embedded within the site layout where systems of power and resistance were negotiated. Although the design team were in a position of power, they did not actively question "historical continuities" in terms of gender structures, perhaps signalling what Foucault referred to as "force relations," where "power relations have become so entrenched that they can seem entirely one-sided and unchangeable" (in Gauntlett, 2002, 1.118). In the context of BEME.com, power relations derive from the commercial tradition of the women's magazine publishing industry that has relied on the continuity of gender structures to generate profit. I argue that there is more to women's use of commercial online spaces than their gender. Female users operate within a highly complex world, of which the Internet is just a part.

FUTURE TRENDS

Design knowledge and experience is based on evaluation of existing and conceivable outcomes, just as consumer surveys are based on reactions to current rather than future designs. This leads to a built-in conservatism in terms of influencing or responding to, consumers. Recent studies of inclusion strategies (Faulkner, Sørensen, Gansmø, Rommes, Pitt, Lagesen Berg, et al., 2004; Rommes, 2002; Spilker & Sørensen, 2000) are incomplete without conceiving of design processes as material outcomes of a social, cultural, political and economic milieu. Faulker et al. (2004) argue, "[t]he market has not generally proved a very innovative mechanism for improving gender inclusion in the information society …" (p. 3). Further cross-disciplinary research into the relationship between design, gender and the WWW is needed to address disparity between the gendered production of online design outcomes and what female users perceive as useful.

Designers need to engage with new paradigms prompting a shift from "product design" to time-based "service design." Here, interactivity could become a key driving force. Burnett and Marshall (2003) argue that online interactivity encourages users to engage in a different kind of literacy encompassing simultaneous reception and production. Understanding consumers simultaneously as producers should have a profound impact on the role design plays in constructing online experiences for female users in the future.

CONCLUSION

An investigation of commercial sites like BEME.com provides important insight into the ways Web design practice attempts to reconcile a critical agenda with gender structures. It illuminates female users' tendency to disassociate with identities constructed in gendered niche marketing. However, the media landscape is changing, where "… the popular … media now promote … a new rhetoric of freedom and independence for young women …" (McRobbie, 1999, p. 11). Therefore, a question arises as to how radical the design agenda can become whilst continuing to operate within a commercial context. Has BEME.com become an example of the need for far more radical design in this commercial sector? Whether BEME.com's closure is attributed to either a strategy of "silence" (Baudrillard, 1985) or merely a lack of interest, it is clear from my research that current commercial imperatives are deeply implicated in gendered structures. BEME.com's original design did not meet these commercial demands and yet neither did its redesign, which, one could argue, "sold out" to commercial priorities. Just as women are clearly not passive consumers, design practitioners in a commercial environment have both the opportunity and a responsibility to affect and *effect* changes to a gendered status quo.

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A LISTING OF DATA SOURCES WITH RESPECTIVE CODE

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2. I-PT2**:** (2002) Female. Editorial/Creative Director. Interview: 20.03.2002
3. I-PT3: (2001) Male. Design Manager/Designer. Interview: 11.12.2001
4. I-PT4: (2001) Male. Brand Designer. Interview: 30.11.2001
5. I-PT5: (2001) Female. Senior Producer. Interview: 28.11.2001

KEY TERMS

Design Practice: It embodies design practitioners' ability to create something new within preexisting conditions and imbue it with meaning decoded and understood by others. It is positioned at a crossroads where the ongoing creation of new solutions meets the need to maintain the existing status quo.

Feminism: Feminism "… acknowledges that women form a group among many in a multicultural society, with different tastes, needs, values, and orders of priority because of the roles they play, the type of jobs they do and the position in society they occupy through the accident of their birth. In this context, feminism is a political position which seeks changes in the interest of women" (Attfield, 1989, p. 200).

Interactivity: Refers to interactions similar to interpersonal communications, where structure of technology, communication context and user perception play an important role. (Kiousis, 2002, p. 372) Interactivity is situated within social, cultural, political, and economic context and sets apart online communication from other media like print, film, or animation.

Patriarchy: Understood as "…a Web of psychosocial relationships which institute a socially significant difference on the axis of sex, which is so deeply located in our very sense of lived, sexual identity that it appears to us as natural and unalterable." (Pollock, 1982, p. 10)

Portal: An online "gateway" considered as a starting point for users when connecting to the Internet. It can act as a point of reference in how to view and organise the information obtained online. There are portals that are general in their services or niche portals that specialise in specific interests.

Service Design: Service design represents design of intangible experiences, happening over time, and reaching people through many different tangibles such as advertising, PC interfaces, retail shops, call centres, and customer representatives. (live|work studio ltd., 2004)

Women's Magazine Publishing Industry: Commercial practice focused on publishing women's periodicals often associated with traditional values, and referred to as "glossy magazines." With the introduction of the Internet, the term has also been used to describe commercial online sites specifically targeting female audiences that subscribe to similar values and practices.

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A Developing Country Perspective on Women's ICT Adoption

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INTRODUCTION

The explosive growth of information and communication technologies has become a worldwide phenomenon. However, merely countries in the West as well as a growing number of countries in Southeast Asia have become largely connected, whereas the majority of people in the developing world have not yet been able to take advantage of the new opportunities ICTs provide. Especially in developing countries, Internet access remains a luxury of small groups of elites, and even the use of old-fashioned telephone lines remains a luxury for a minority of the people. While the lack of availability of technological infrastructure looms large, the basic lack of education and technical skills impedes further potential for the large-scale adoption of ICTs (e.g., Cawkell, 2001).

The opportunities of ICTs are commonly discussed in terms of business opportunities—as a means to enhance economic competitive position at either the level of the firm, region, or nation. This entails a narrow scope. ICTs have the ability to enhance the quality of life in a broader sense as they have the potential to improve interpersonal communication, and moreover could allow for the social and political empowerment of ordinary people (e.g., Hafkin & Taggart, 2001). This implies a direct downside as well: Those people with significant access to ICTs and thus information resources are in a position to increase their control over social, political, and economic arenas, making nonusers further marginalized and excluded from not only economic life, but social and political life as well (e.g., Cawkell, 2001; Morales-Gomez & Melesse, 1998).

In this regard, Forestier, Grace, and Kenny (2002) have found that, historically, telecommunications rollout has actually increased inequality because only the wealthy can afford implementation and use. Nevertheless, the authors also find that both telephony and Internet access could be a force for the convergence of incomes and widespread improvements in quality of life in the future, as costs of ICTs are decreasing and hence access becomes a possibility for the poor as well. Nevertheless, in the case of the Internet, the absence of policy initiatives with regard to access coverage, training, and content development aimed specifically at the poor make it likely that this new technology will also be a force for further income divergence like telecommunications rollout has traditionally been (Forestier et al., 2002).

BACKGROUND

While more awareness is being raised concerning this digital divide, problems are often expressed in the number of Internet connections or the extent of ICT deployment at the country level, which does not provide us with adequate insight into the factors within such countries leading up to the challenges (e.g., James, 2005). A variety of specific factors influencing the digital divide and access to ICTs in developing countries needs significant in-depth exploration if we want to change the situation.

For example, it is well known that most countries face a significant urban-rural digital divide: In urban areas and especially major cities in developing countries, typically a significant number of phone lines is deployed as well as means for access to the Internet, but rural areas often lack basic infrastructure. Nevertheless, while the case has been made that improved telecommunications or access to ICTs will permit improved cost benefits for rural economic activity, these discussions often neglect the impact that urban-rural connectivity could have on local trading in rural areas and the possible danger for the destruction of relatively self-contained rural economies (Samarajiva & Shields, 1990). Thus, while ICT may provide great benefits, its introduction may also induce further dependencies of the poor on the wealthy.

Alongside this rural-urban divide, we find that among the least connected in the world are women in developing countries, in particular those women living in rural areas. Moreover, the majority of women are located in rural areas, situating them in the deepest part of the digital divide. Problems for the integration of these populations in the information era depend not only on the lack of infrastructures and the high costs of ICT deployment, but even more so on illiteracy, unfamiliarity with the dominant English language in Internet content, unfamiliarity with the use of ICTs, and the lack of availability of software and content suitable for use. People's information needs in developing countries may be very different from people in Western countries, depending on social and cultural (work and household) practices.

While these issues provide a major challenge for appropriate ICT introduction and uptake, James (2005) shows that it seems often forgotten that even though individual access is very limited in developing countries, a remarkable number of local innovations have been made available to some 10 million people within developing countries. While many of these people are illiterate, have limited skills, and live in rural areas, significant progress is being made. Therefore, James (2005) argues that national governments and foreign donors need to pay less attention to providing individual access facilities and need to focus more explicitly on ways to enhance indigenous rural innovation systems devoted to finding relevant and cost-effective applications of the Internet.

From this it follows that social and cultural context provide the backdrop against which ICT implementation for any particular group of people, and thus indeed for women too, is appropriated. This means that while women's adoption of ICTs would provide a means for sociocultural empowerment, at the same time we need to acknowledge that these sociocultural issues, and thus women's position and role in society, will provide constraints for the adoption of new technologies. Thus, we need to understand the very specifics of women's lives in their particular communities in order to be able to change the situation in an appropriate manner.

In order to illustrate some opportunities and constraints for implementing ICTs in line with women's social and cultural context, a short overview of women's lives in Bangladesh will be provided along with background information on current ICT implementations.

THE CASE OF BANGLADESH: WOMEN'S USE OF VILLAGE PHONES

Bangladesh is one of the least developed countries in the world,[1] facing very high poverty levels. While it is one of the most fertile countries on earth, annually about one third of the country gets flooded during the monsoon season. The country has a high population density and is currently inhabited by about 144 million people, of which nearly two thirds are employed in the agricultural sector.[2]

The use of ICTs in Bangladesh is rapidly increasing, and government initiatives and policies on ICT have been in place for already over 20 years.[3] However, as explained by Bhuiyan (2002), while ICTs were introduced a long time ago, the majority of computer installations currently are significantly underutilized; moreover, the functions for which they are being used remain limited, partly due to the lack of people with computer qualifications, skills, and experience. The additional inadequate local market for hardware and software development makes installations vulnerable. Also, the lack of understanding at senior levels of the potential of these already implemented ICTs hampers further appropriate uptake. Finally, the out-of-date telephone systems and the erratic power supplies restrict further development of ICT potential (Bhuiyan, 2002). Nevertheless, increased deployment of ICTs in Bangladesh has been argued to be able to stimulate socioeconomic growth: It could allow not only for market growth and the creation of an efficiency-oriented economy or administrative restructuring, but for community development, personal growth and self-reliance, and the integration of women into the mainstream of development planning as well (Bhuiyan, 2002).

While these typical ICT deployments have provided opportunities only for a small part of the population, especially for the higher educated workforce, in the last few years the upcoming of cellular technology has provided a great leap forward for Bangladesh. Grameen Phone, under the umbrella of Grameen Bank, has introduced the Village Phone Program. The Village Phone Program focuses on rural cellular communication connectivity, especially for the poor population. As this short overview will show, the program has increased connectivity and to some extent has enhanced the empowerment of women. Before turning to some of the specifics of this program, some background will be provided on women's role in Bangladeshi society.

Women's Role in Society

Like in many other developing countries, women in Bangladesh are severely restricted in mobility because of their traditional roles in the household.[4] Their activity space is closely tied to the neighborhood, while public roads and markets are primarily male spaces where women may only go in appropriate company as well as appropriate dress (Paul, 1992). Nevertheless, female space in rural Bangladesh has been expanding in recent years as a consequence of socioeconomic changes related to increasing landlessness and impoverishment (Paul, 1992). Yet, the expansion of female space nevertheless is not uniform across socioeconomic classes.

While more women now seek access to the labor market, which has long been dominated by males, and generally speaking women constitute an important part of the labor force in Bangladesh, it is mainly in the bigger cities where one will see women working in income-generating jobs such as in factories. A research project taking place in the summer and fall of 2001 in which the author was engaged[5] found that in the rural areas, women's roles are more traditional: Women work very hard from early morning until evening, but typically in nonwage jobs within the family sphere where they take care of household matters (getting water, cooking, cleaning, taking care of children), and in addition also often engage in work related to the family practice such as, for example, drying rice.

Furthermore, it was noticed that in Hindu settlements (North Jalirpar, Gopalganj), women could walk around rather freely, but they would mainly stay within their clan (family) settlement, walking about 250 meters to collect water, at the most. Women would usually only leave town to visit family, guided by other family members. Males do the grocery shopping, visit markets outside of town, sell their own produce, and so forth. In Muslim villages in the Sonargaon area (a peri-urban area close to Dhaka), women's mobility seemed even more bound to their own family settlement.

With these restricted roles, it is not surprising that the majority of women in Bangladesh are illiterate. Girls often leave school before they reach the high-school level because parents do not have enough financial means. Moreover, one of the major social issues is parents trying to have their daughters married at a very young age so that their husbands can provide further financial support. Thus, girls at a very young age are prepared and taught matters of taking care of the household rather than learning at school, keeping illiteracy numbers high even though awareness of the positive impact of education is evident.

These social spheres and related roles for women obviously have their effect on women's engagement in the world beyond their family settlement. With women typically spending their days within their family settlement, social, economic, and political empowerment are likely to remain limited. Nevertheless, increasing possibilities for communication in Bangladesh have the potential to slowly bring some change. Women's restricted mobility implies limited possibilities for accessing ICTs far away from home, and moreover, illiteracy rules out the use of advanced Internet technologies. However, Grameen Bank's Village Phone Program provides services considerate of these limitations, allowing for enhanced communication possibilities and hence more empowerment.

Grameen's Village Phone Program

Grameen Bank has a history in providing services for the poor, of which its microcredit program has become a world-renowned model for poverty alleviation. Grameen Bank targets women by providing them with small loans in order to stimulate socioeconomic growth. Grameen Bank moreover often integrates microcredit programs with women's discussion groups in order to disseminate information on health issues; to provide literacy training and skills development; to educate on family planning and political consciousness, and so forth (Richardson, Ramirez, & Haq, 2000). This program has been imitated extensively by other non-governmental organizations (NGOs) throughout the country. However, the extent to which microcredit programs have a positive impact on women's empowerment is scrutinized. Both positive and negative stories have been heard. Some programs demand women, after saving some money, to buy goods from the organization originally providing the credit and thus increase women's dependency as opposed to independency. Other microcredit programs, however, have been reported to have allowed for significant empowerment (e.g., Amin, St. Pierre, Ahmed, & Haq, 2001).

Grameen Bank has expanded its development services with Grameen Phone, introducing the Village Phone Program. In this program, Grameen Bank leases cellular phones (village phones) to successful microcredit members. Village members can go to the village-phone owner to make phone calls, and at the same time owners bring the phone to village members when they receive a call. Village-phone operators are typically women, as 95% of Grameen Bank's members are women because of its microcredit program (Richardson et al., 2000). While the owners are generally rather poor because of their involvement with Grameen Bank's microcredit program, these people at the same time have been reported to do relatively well as they are leaders in terms of literacy, child immunization rates, and the use of safe drinking water and sanitary latrines (Richardson, et al., 2000).

The Village Phone Program has been reported to have increased socioeconomic benefits for its users, foremost to phone owners but also to the larger community. First, substantial revenues are earned through the phone, and additionally, female owners seem to gain more decision-making power within the household by being part of this revenue-generating activity (Richardson et al., 2000). While it has been reported that phones are often in the husband's control during the day (Richardson et al., 2000), female owners' degree of mobility in and around the village has significantly increased because incoming phone calls sometimes make it necessary for the phone owners to take the phone to village members. Bayes (2001) furthermore finds that women's knowledge was increased because of overhearing other people's phone calls. For example, they have been reported to learn about the names of places where phone calls originated and about new markets.

With respect to benefits to the larger community, we see, for example, that other women in the village come to the phone owner to make phone calls, which increases their mobility within the village. Mobility and social contact outside the village are also enhanced: Families visiting relatives outside the village contact them by phone and inform them of the time of arrival, thereby reducing family tensions and conflict and strengthening family relations (Bayes, 2001). Finally, beyond these direct benefits to the people involved in the program, an extra benefit comes to the fore in the actual involvement of poor people in telecommunications supply: They are becoming actual managers of new technologies and hence are able to use and provide technology according to their specific culturally and socially appropriate needs.

CONCLUSION

The background discussion indicated that while significant efforts are being put forward to provide more attention to the potential benefits of ICT deployment for socioeconomic development in developing countries, mainstream discussions typically remain at an abstract level. More than often, the specific needs of particular groups of people are not explicitly addressed. As we saw, women in developing countries remain in the deepest part of the digital divide; however, only few studies have been conducted into women's uses of ICTs within particular communities.

The brief example provided here about women's village-phone use in Bangladesh highlights how the use of ICTs is embedded within women's social and cultural contexts. While Bangladeshi women's education levels are generally very low, mobile communication has shown to provide opportunities for illiterate people as well, and as the village phone is employed by other women in the community, the service has become rather accessible according to social norms. Even though the village phones are still used on a relatively small scale, the example of this program indicates that increased communication allows for more social and economic empowerment: Not only does the program allow for the improvement of women's economic status in terms of business practices (e.g., selling a product), but at the same time it also provides (some) women in the communities at large with more social inclusion because of the ability to reach family in neighboring villages, as well as to learn more about what is going on in their surroundings because of their enhanced mobility.

Even though this article only touches upon a few issues and is everything but exhaustive, it does point out areas where significantly more research is needed: namely, the social and cultural aspects of communities and their influence on ICT uptake. More research focusing specifically on women's communication needs as related to their cultural and social backgrounds is needed in order to develop and implement relevant communication technologies that may in the end allow for an incremental increase in women's social, political, and economic inclusion in society. This needs to not only happen for areas in Bangladesh, but for many locations across the globe. And, not only groups of women are in the digital divide; hence, empirical research on other disadvantaged groups of people and communities in particular locales will improve our understanding and may help us to better understand how culture relates to technology adoption and use. As the discussion has pointed out, social and cultural understanding is the number-one key to being able to implement appropriate systems that do just to people's current needs and at the same time do not interfere with current social and cultural practices.

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KEY TERMS

Bangladesh: A developing Southern Asian country positioned as 138th out of 158 countries on the human-development index scale. It borders India and Myanmar, and has a population of 144 million people (in 2005), of which approximately two thirds work in the agricultural sector and 57% are illiterate.

Digital Divide: The (social) gap between (groups of) people who have and people who do not have access to information through the use of ICTs.

Information and Communication Technology (ICT): Includes both information technology for (computerized) information processing and communication technology such as (mobile) telephony communication.

Urban-Rural Digital Divide: The gap between rural and urban communities in their access to information through the use of ICTs.

ENDNOTES

1 Bangladesh is 138th out of 158 on the human-development index scale. See http://www.nationmaster.com/graph-T/eco_hum_dev_ind

2 http://www.cia.gov/cia/publications/factbook/geos/bg.html

3 http://www.elcot.com/mait-reports/MAIT%20Country%20Intelligence%20eNews21.pdf

4 While in general we may perceive females' activity space as related to cultural, social, political, religious, and economic systems, Paul (1992) explains that female space in rural Bangladesh is particularly closely linked to purdah, the patriarchal family structure that is rooted in Islamic doctrine.

5 Experiences are documented in Einwachter, Van Gorp, and Hilders (2001).

Digital Divide, Gender, and the Indian Experience in IT

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INTRODUCTION

Information technology is being perceived as the magical wand and the harbinger of prosperity as it can guarantee access to global markets and enable direct foreign investment and e-commerce. Several projects aim at bringing information technologies to India with a belief in the transforming potential of IT. However, these technologies have created a digital and gender divide. In this article, attempts have been made to look into the digital divide and the constraints that women share by gender specifically in India.

India is a multilateral, multilingual, and multireligious society with many subdivides based on region, ethnic groups, class, and caste. The digital divide and gender has become yet another component of this diversity. In India, women comprise 14% of the IT industry and 26% of the business processing outsourcing (BPO) workforce. The total workforce of IT and BPO is made up of approximately 70 million people (http://www.ciol.com). At the lower experience level (about 3 years), about 19% of the workforce comprises women. At senior levels, women constitute less than 6% of the workforce (http://www.dqqindia.com). This indicates that few manage to reach the top level, and the majority of them remain at lower levels as computer or data-entry operators.

The gender gap in the digital divide is of great concern as it is directly linked to socioeconomic development. A major developmental issue of the coming decades will be the access and use of IT (Organization for Economic Cooperation and Development, 1989). Policy makers of both industrial and developing countries have agreed that IT is one of the fastest growing industries and is likely to be the largest by the turn of the century (Kraemer, 1994). Hence, if women are not actively present at all levels in this growing industry, then we would see marginalization that could undermine the advances made by women in other fields in the 20th century.

BACKGROUND

Colonial rule had deprived India of an industrial revolution. After gaining independence in 1947, India had adopted an economic policy that largely favored public-sector expansion. In this strategy, private and foreign capital were strictly controlled by the government. India's opting for a mixed economy also reflected the country's approach to high-technology industries (Harindranath, 1999). During this period, multinationals such as International Business Machine (IBM) and International Computer Limited (ICL) leased obsolete technology to India. Though the state-owned firm Electronics Corporation of India Ltd. (ECIL) entered into the indigenous manufacturing of computers in 1971, it could neither fully embrace the technology nor satisfy the growing demand of the country (Subramanian, 1992). In 1978, private-sector entrepreneurs entered the computer-manufacturing industry, which was supported by the national computer policy of 1984 (Government of India [GOI], 1984).

This above-mentioned policy was totally reversed in 1991 when the government of India adopted the New Economic Policy (NEP), which was further refined with stabilization and structural adjustment measures as advocated by the World Bank and International Monitory Fund (IMF). In 1998, GOI constituted a national task force on IT and software. The recommendations of this task force provided the directives, incentives, and concessions for the establishment and expansion of the IT industry in India. Accordingly, IT companies were exempted from income tax for 10 years. Further more, the govern-

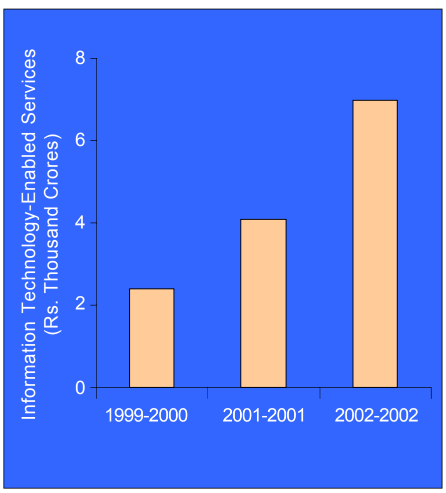
Table 1. Knowledge professionals employed in Indian IT sector

Category	1990-1991	1996-1997	1999-2000	2000-2001	2001-2002
Software export sector			110,000	162,000	170,000
Software domestic sector			17,000	20,000	22,000
Software-captive in user organizations			115,000	178,114	224,250
IT-enabled services			42,000	70,000	106,000
Total	**156,000**	**160,000**	**284,000**	**430,114**	**522,250**

ment gave land for the building of IT companies. Concessions were also given on sales tax, electricity, and import duties (Chowdhry, 2002). As a result of all these efforts, India became an important player in the IT sector.

The software industry, which was started in the early 1970s, has grown at an exponential rate since the 1980s (Heeks, 1996). In the beginning, much of this work was carried out at the clients' facility located elsewhere rather than in India (Mitter, 2000). Recently, IT-enabled services such as call centres, customer interaction, back-office operations, insurance claims processing, medical transcriptions, and database management have further enhanced the scope of the IT industry in India. From a base of 6,800 knowledge workers in 1985 and 1986, the number increased to 522,000 software and services professionals by the end of 2002. It is estimated that out of these, almost 170,000 are working in the IT software and services export industry, nearly 106,000 are working in IT-enabled services, and 220,000 in user organizations (Table 1; http://www.nasscom.org.in). Hence, today IT is emerging as a major industry with increasing revenues (Figure 1).

Figure 1. Increasing revenues from IT



Note: about 45 Indian Rupees = $1
1 cror Indian Rupees = 10 million Rupees
Source: NASSCOM (2001)

WOMEN AND IT EDUCATION

Women's participation in the country's IT growth is determined by the low status ascribed to them in Indian society, extreme poverty, and poor IT infrastructure. Since most women lack literacy and basic education, specialized IT education is out of reach for many women. Like in many parts of the world, by and large girls take up courses in arts subjects only, and very few girls go for science subjects, especially engineering and IT. Female youth literacy is at 44%, and only 23% of India's Internet users are women (United Nations Education, Scientific and Cultural Organization, 1999)

Since very few women opt for engineering courses, an insignificant number of them pursue specialized training in IT. By and large, women face challenges in pursuing education at all ages because of the lack of time to attend school, familial and household duties, and sociocultural norms that give a low priority to education. In general, men are more aggressive than women, and this norm manifests itself in the interaction of boys and girls in the sharing and use of the computers. Recently, the National Institute of Information Technology (NIIT) conducted a project entitled Hole in the Wall in rural and urban areas. Their studies clearly indicated that computer use was evenly distributed between boys and girls in rural areas, but was higher among boys than girls in urban sites (Mitra, 2001).

It is common observation that women get less benefit from IT because of cultural restrictions imposed on their mobility. For example, it is often seen that fewer girls visit cybercafes than boys. Few IT-trained women would dare to move out of their hometowns and live alone in urban areas. Contrary to urban areas, the presence of IT in rural India is negligible. More than 60% of Indians live in villages, and women comprise at least 50% of them. There is an urgent need to introduce and expand IT in rural areas in order to create awareness among women. The digital divide in IT runs parallel to the rural-urban divide and the gender gap (International Telecommunication Union Task Force on Gender Issues, 2000).

INFRASTRUCTURE ISSUES

Despite its ambition to emerge as a global leader in the IT software sector, India lags behind in infrastructure. According to the Infrastructure Environment Index (IEI), it ranks 86th out of 104 countries. However, in the Environment Component Index (ECI), which measures the market, political, regulatory, and infrastructure environment, India ranks 38th (Financial Express, 2005). According to the GOI census of 2001, about 285 million Indians live in urban areas, a figure that approximates the population of USA. Out of 285 million, about 76 million Indians live below the poverty line in urban areas, which is equivalent to the population of Mexico. This still leaves 742 million Indians living in villages (http://infochangeindia.org/urban). Within the poorest households both in urban and rural India, women are poorest of the poor, which provides adequate evidence that IT access factors have a clear gender dimension. In general, in comparison to men, women suffer from an overload of demands on their time, leaving them with less opportunity to learn vocational skills in IT. The further lack of information and use of skills has a gender dimension as women's isolation gives them fewer opportunities to broaden their range of comprehension (Hafkin & Taggart, 2001). This suggests that there is a need and ample scope for the development of infrastructure in IT in both urban and rural areas, which may provide opportunities for more women to learn and join IT-related jobs.

GLOBALIZATION, INFORMATION TECHNOLOGY, AND WOMEN

Globalization involves the spatial and temporal reorganization of industries across borders and the spread of financial markets that resulted in integration and partnership building in flexible, commodity-based production systems. The field of operation is characterized by the redeploying and movement of capital across locations of their production at will.

The new vistas of business have now emerged as a global market. In many countries, women became the preferred candidates for certain jobs needed in a global economy. These ranged from manufacturing, where they were regarded as nimble, docile, and more able than men to perform repetitive tasks, to services (including everything from data entry to domestic and sexual services). A major motivation in shifting the geographical division of labor was the search for cheap labor, which was frequently associated with women workers (Hafkin & Taggart, 2001). Since the 1970s, an unprecedented number of women workers from developing countries entered both the formal and informal labor force to service the global economy, resulting in increasing marginalization and pauperization (Pande, 2000).

With the change in technology, women's work has considerably changed (Mitter, 1999) as follows.

- First, the work of women changed by the altering of the process of production in the manufacturing and service industries through automation, the de-skilling of workers, and the augmenting of the skill requirements of key jobs.
- Second, it changed through the introduction of new products or services in the market, such as electronics, computer peripherals, and information-processing work.

- Third, production that often uses old technologies shifted to locations that are distant from the main sites of commercial units or to home-based workers.

There has been a change even in the manufacturing sector. Employment in information technology in manufacturing has changed from making information technology in electronic assembly lines to using information technology in nearly every manufacturing industry. Globalized manufacturing still demands cheap labor, mostly located in the developing world, but with greater technical and cognitive skills. In the move to the knowledge economy, computer-literate, skilled technicians and engineers are needed, and nimble fingers have become largely redundant (Hafkin & Taggart, 2001). In spite of this change, women are conspicuously absent from decision making structure in developing countries. Decision making affects what the IT sector produces and how it organizes production and interacts with society. The existing systems of production and organization of the IT sector negatively affects women and continue traditional system of gender relations (Marcelle, 2000).

The emerging gender employment pattern in the IT sector is a cause for concern. Women are only employed in desktop publishing and software programming. A majority of them are employed in lower skilled IT jobs such as word processing and data entry. They are not employed in technical jobs such as designing, operating systems, and computer maintenance. Though globalization has opened vast opportunities in the IT sector, it has not improved the scope for women employment.

Overall in Asia, IT industry development followed two distinct phases. In the first phase, women were absorbed in the labor-intensive computer-assembly jobs (Castells, 1996). India also followed a similar route in the formative years of its IT industrialization, and women were absorbed in assembly-line jobs. In these jobs, women used to work for more than 10 hours a day; these were unusually long hours of work for miniscule wages according to any standard of measurement employed in judging the efficiency in developing countries. Furthermore, poor working conditions and exploitation by the employers added yet another dimension to women's employment in the potentially growing IT industry, particularly in India.

In the second phase that began in the 1980s, IT emerged as a service-provider industry. Accordingly, employment opportunities and employment patterns also changed. In this phase, manufacturing became more automated and required greater technical and cognitive skills than in the first phase. This resulted in a substantial drop in the number of women employees in the IT manufacturing industry.

Today, the world market for IT services is stated to be worth around $220 billion, and this is growing around 14% every year. India has several competitive advantages that enable it to tap into this huge market: the second largest pool of technical talent in the world after the USA, an attractive wage structure, and the possibility of providing clients a 24-hour workday by exploiting time-zone differences (Murthy, 2000). This new opportunity has once again opened a differential scope for women's employment in the IT industry. In the move to the knowledge economy, computer–literate, skilled technicians and engineers are needed. However, the jobs that are created in the new technology sectors are fewer than had been created in manufacturing. While globalization has brought new opportunities to young women with familiarity with English in new service-sector jobs, it has also made a vast number of women who are over 35 years old redundant (Pande, 2005).

India is emerging as the call-centre capital of the world, and many multinational companies and start-ups are setting up operations here. The worldwide demand for IT-enabled services is expected to grow at an exponential rate. As the sector with the most rapid momentum, it has been growing at a sustained pace of 50% per annum. According to an Industrial Design Centre (IDC) study, the Indian IT industry will grow to Rs. (Rupees) 247,000 crores ($53 billion) by the end of calendar year 2008 from Rs. 87,000 crores ($18.7 billion) in 2003 as per the India Brand Equity Foundation (http://www.ibef.org/industry/ITenabledservices.aspx). India hopes to capture a large share of this newly created market with revenues of $870 million from IT-enabled services in 2000 to 2001 with an annual growth rate of 66% (http://www.nasscom.org). This has been strongly supported by the data presented in Figure 1. Through these new technologies, a large amount of informa-

D

tion can be transported at very low cost from core office establishments to satellite or subcontracting units located around the globe. This possibility has led both private and public enterprises to externalize and decentralize noncore sections of their businesses to distant locations, often where trained human resource in IT is available at more economical and greater profitable rates than at the headquarters. Table 2 shows some of the latest available statistics with regard to outsourcing in India.

Outsourcing sites are often located in developing countries such as India, which have a comparative advantage in providing cheap workers who are skilled in computer use and have a good command of the English language. In this context, India has become an obvious and preferred choice of several multinational IT industries for establishing even full-fledged offices in cities such as Bangalore, Delhi, Hyderabad, and Chennai.

In some ways, the spread of IT-enabled services has been immensely beneficial to both women and men, especially those who have adequate skills but lack the resources to invest in higher education. The revenues in these services are increasing every year as shown in Figure 2. The employment of girls and women has grown enormously in these IT-enabled services such as the following:

- Call centres
- Back-office operations
- Medical transcriptions
- Online education
- GIS (geographical information system) services
- Computer-assisted animation

In these offices, job responsibilities have been restructured into two main components: administration support that deals with decision making, and technical support that is mainly responsible for the execution of tasks. The division of job responsibilities has infrastructural support by advanced tools in IT technology such as high-speed Internet, global connectivity to workstations, and high-volume communications networks. In general, it has become possible to spatially separate routine back-office tasks from nonroutine work (Greenbaum, 1995).

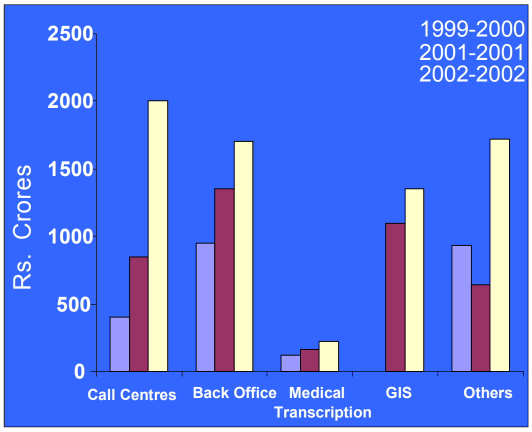
In general, minimum wages in India are just over Rs. 1,000 per month (about $20), but in the IT-enabled industry, wages can range from Rs. 5,000 to 15,000 ($102 to $306), which is 5 to 15 times more than normal minimum wages (Kelkar, Girija, & Veena, 2002). Therefore, employment for girls and women has become very attractive in some of these areas of outsourcing. Most of the women employed in call centres are between 20 and 25 years of age, and most of them work in back-office services; in most cases, this is their first job (Pande, 2005). As these services require rather routine, low-level, or limited technical training, women usually predomi-

Table 2. Recent figures related to IT growth

Figures	Estimates Related to India
$12.2 billion	Estimated worth of software exports by the end of 2005
21.7%	Expected annual growth in IT sector, which is the fastest in Asia Pacific
$4.9 billion	Estimated worth of India's information-technology market
$17.2 billion	Revenue from outsourcing in 2004 to 2005
$22.5 billion	Expected worth of back-office exports by the end of 2005
51%	Percentage of share in global outsourcing by 2008
$0.58	The cost saved on every dollar spent on offshoring by U.S. firms

Source: India Today Survey, Independence Day Special, August 22, 2005

Figure 2. Increasing revenues from IT-enabled services



Note: about 45 Indian Rupees = $1
1 cror Indian Rupees = 10 million Rupees
Source: NASSCOM (2001)

nate here. Their jobs include activities such as taking customer calls, data entry, processing transcripts, service-claims processing, and remote sectary services. It is very difficult for these women to move into higher skilled, better paid jobs such as software development and programming or geographical information system analysis. There is no scope for the upgrading of skills, and women continue to work in the same kinds of jobs with only few degrees of variations.

One can observe a kind of hierarchy in the call-centre industry. Financial services such as those providing access to credit cards, insurance, stock markets, and bonds enjoy a higher status. Even sales and marketing enjoy a higher status than customer care. While the first is more output oriented, the latter is more quality oriented (Pande, 2005). Even if women are able to acquire better education and training and begin to enter IT fields in great numbers, women's leverage in the IT job market may be undercut by the feminization of labor. As computer-based skills become more commonplace and the need for more workers to use them in a greater variety of ways grows, more women will be again recruited but at lower wages. The recent law in America that stops government from outsourcing its work in developing countries will still hit at this sector.

Globalization has not changed the gender division of labor. The least skilled level of work with the lowest remuneration continues to be assigned to women following the nearly universal gender division of labor and patterns of work organization. For poor women, the existing inequalities and insecurities have intensified. Globalization has only widened gender disparities and increased the feminization of poverty (Pande, 2001). Some unskilled women have lost their livelihood as alternative sources produce goods cheaper and faster. For some women, it has meant a loss of rights, benefits, and job security. Globalization has also led to the migration of a large number of women from developing countries (Pande, 2000).

FUTURE TRENDS

Computer networks have altered the concepts of space and time. They allow multinational companies to provide real-time services all the time. Customer requests can be transferred across continents and time zones without the customer even knowing that work is being done on the other side of the world. For the first time, time and space independence is achievable for any business that operates in the global market. So, enabled by new technology, today's global businesses are not so much multinational as transnational (David, 1999). Hence, we will have more and more women entering IT.

In the future, all jobs related to information processing will be done entirely by women because of the association of women with typing and other kinds of secretarial work. Despite the assembly-line, "electronic-sweatshop" nature of the work, employers try to instill the idea of professional stature in the job by enforcing "pink-collar" dress codes of suit skirts and high heels, required by the job but not by the work (Freeman, 2000). Underlying the factory nature of the work, shift work is the norm with many companies operating around the clock. All this, however, will not ensure prosperity for women. Economic growth is not an end but a means to a better quality of life. One has to keep in mind the human face of economic growth.

The advent of globalization has brought changes even to the location of IT-enabled work. Women's work has been organized in two ways: home-based work and telework. In the first, using old technologies and facing increased international competition from automated manufacturers, companies shift production to the informal sector through subcontracting at reduced costs. Women who have lost formal-sector manufacturing jobs frequently turn to these less desirable jobs to remain in the labor force. The work here is done at home or in small units. Workers have none of the benefits of the formal sector, like fixed contracts, maternity leave, and unionizing. Like in other unorganized-sector work, they suffer from the lack of opportunities to work, low and discriminatory wages, and exploitative conditions resulting in casualization (Pande, 2002; http://twcu.ac.jp/). Teleworking is another kind of reorganization of women's work using new technology. Teleworking refers to distant working in which employers or freelance workers use telematics at a site that is geographically separated from the main site. As in IT-enabled services, this also involves a location set up, mostly in developing countries, that is different from the main office, which is often in developed countries. Many young girls join these and have to work throughout the night in order to keep up with Western time.

The rhetoric of globalization promises to remove backwardness through a worldwide exchange of information and skills in order to establish a truly cosmopolitan culture. There is an underlying belief that mutual cooperation and concern for social justice is automatically cared for under this system. In actual practice, since the global order is based on unequal power relations, these concerns are put on hold. Globalization creates the ghettoization of weaker nations and the weak among them. It seems to increase choices as trade does, but only for those with money and access to the market. Due to the existing differences between women's and men's access to knowledge, skills, responsibilities, concerns, and control over resources, they are affected widely by the global process.

It is a paradox of the information society that while on one hand the world is apparently shrinking all the time and distances never matter, where you are born and brought up has a lot of implication for your future. So, if you are an ambitious female computer-science graduate, you have a good prospect if you live in California or New York. But if you are born in India and live in Delhi or Hyderabad, you had better start practicing saying, "Hi, my name is Shirley. How can I help you?" and keep that smile forever in your voice while most of the others in your country are fast asleep, as the jobs that will be available will be only in IT-enabled services.

CONCLUSION

Therefore, to conclude, while information and communication technology has become a potent force for transforming social, economic, and political life in the globalized world, the gendered division of labor is already emerging. A large number of women tend to be concentrated in the end-user, lower skilled jobs and comprise a very small number among managerial, maintenance, and design personnel. In India, women's ability to participate in information technology is determined by the low status ascribed to women and girls in Indian society, and the extreme poverty and poor infrastructure that restrict women's access to education and information technology.

In the context of globalization and shifts in the structure of the international economy, technology-related changes in manufacturing processes have eliminated women's jobs or put them in new jobs with harsh conditions and low pay. IT-enabled services have recently expanded in India to build upon the traditional Indian values of quality, customer service, empathy, and courtesy. They have utilised the available human resources of a large pool of English-speaking youngsters and the globally competitive cost advantage. In some ways, the spread of IT-enabled services has been immensely beneficial to both women and men, especially those who have limited skills and lack the resources to invest in higher education. This has also brought some amount of mobility to single women, but by and large, it has not really changed gender relations at home.

Hence, while there are many subdivisions in India by region, class, race, caste, location, and ethnic origin, a major digital divide is by gender. Many of the constraints that women face are due to the poverty they share with men. The gender gap between men and women and how they benefit from information technology has widened because women receive less technical education when compared to men and are less employed in technology-intensive work. This is relatively true in rural areas among the poorer population, where women are already disadvantaged by their relative lack of education. Globalization has further complicated the issue. There has been an increasing feminization of lower level jobs. Technologies reveal the societies that invent them and use them, and their notion of social status and distributive justice. In opposition to global capitalism, there is a need for an alternative, community-based technology redefining knowledge in such a way that the local and diverse become legitimate, and women get equal representation. In India, the present technology and the way in which knowledge is constructed currently reflect men's world, and the struggle to transform it demands a transformation of gender relations.

NOTE

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KEY TERMS

Back Office: Operations defined as a wide range of noncore service functions of any organization that can be delivered off site.

Call Centres: Sometimes defined as telephone-based shared service centres used for a number of customer-related functions like marketing, selling, information dispensing, advising, giving technical support, and so forth.

Computer-Assisted Animation: Today, most production outfits use only computer-oriented technology for doing work. Graphics, animation, and special effects have become almost the sole preserve of computer systems.

Geographical Information System (GIS): Growth is driven by the rapidly spreading use of mapping and spatial-data technology in brand new disciplines by new customer-representing industries, markets, and applications.

Globalization: The process of businesses becoming international.

Information Technology: The use of technologies from computing, electronics, and telecommunications to process and distribute information in digital and other forms.

IT-Enabled Services: They typically include functions and services provided from a country different from the one where the end products are delivered. Services are either externally contracted (outsourced) or are provided by a remote subsidiary of the same company (out-located).

New Economic Policies: They consist of two measures—the stabilization and structural-adjustment measures—advocated by the World Bank and IMF. The former relates to the control of the fiscal balance and the balance of payments, and the latter aims at improving efficiency and productivity, and integrating the Indian economy with world trade and capitalist movements.

Online Education: Education occurring between two computers in the same town or between computers on the opposite sides of the earth.

Directing Equal Pay in the UK ICT Labour Market

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INTRODUCTION

The UK labour market is dramatically changing, with rapid technological innovations alongside globalisation where organisations are required to place a premium on human and intellectual capital. The demand for labour is outstripping supply, and businesses are increasingly dependent on their ability to attract, invest in and develop their workforce (Kingsmill, 2003). However, a recent comparative report of the information technology (IT) workforce in Holland, Germany and the UK indicates that women are haemorrhaging out of the IT sector (Platman & Taylor, 2004). Given that presently there is an IT specialist's skills shortage of 18.4% (IER/IFF, 2003), and female IT managers represent a mere 15% of ICT managers, 30% of IT operations technicians and 11% of IT strategy planning professionals (EOC, 2004a), this suggests that the ICT industry is not equipped for equality and diversity at work.

Despite many years of egalitarian rhetoric and 3 decades after the UK Equal Pay Act (1970) was introduced, women still receive on average 18% less than that of their male counterparts working full-time and 41% less than men when working part-time hours. The ESF-funded DEPICT project seeks to identify pay discrimination experienced by women in ICT at a national level throughout England. An important aim is to highlight the impact of pay and reward discrimination has on the underrepresentation of women in the ICT labour market. From this study, we hope to more clearly understand the reasons for the gender pay gap, particularly in the ICT sector; and the impact this has on women's entry and retention to occupations where they are already severely underrepresented. Equal pay is an issue for all; it's unjust, unlawful and impacts on social justice, equality and economic performance (EOC, 2001b). Pay is a major factor affecting relationships at work; distribution and levels of pay and benefits affect efficiency of organisations, workforce morale and productivity. It is vital for organisations to develop pay systems that reward workers fairly for the work they perform (ACAS, 2005).

WHAT IS THE GENDER PAY GAP?

The Equal Pay Act was enacted in 1970 and came into force in 1975 in the UK At that time, the gender pay gap stood at 36%—today, 35 years later, the pay gap remains obstinately at 18%. For women who work part-time, the pay gap is even larger, at 40%, similar to 30 years ago. The gender pay gap compares the earnings of female and male employees, while the gender income gap compares the individual incomes of all women and men. The gender gap between women and men's mean[1] individual incomes in 2002-2003 was 46%, and the gender gap between women and men's median income was 47%. (EOC, 2005c)

Thus, the gender pay gap is the difference in average earnings between men and women and is usually measured by hourly rate or weekly wage. Previous to the Equal Pay Act (1970), evidently the main cause of the gender pay gap was direct sex discrimination, and historically, women received up to half the pay of men even when performing the same job. After the introduction of the equal pay legislation, which prohibits employers from paying women less than men purely on the basis of their sex, the continuing gap was attributed to occupational segregation, indirect discrimination and human capital factors (for example, attainment of qualifications and experience).

ROOTS OF THE GENDER PAY GAP

The Equal Opportunities Commission (EOC) set up an Equal Pay Task Force in 1999 to explore the gender pay gap issue (EOC, 2001a). They reported three main contributors to the pay gap: occupational segregation, discrimination in pay systems and caring responsibilities.

- **Occupational Segregation:** The UK labour market is highly segregated, both horizontally and vertically. Horizontal segregation has led to 60% of the female workforce working in only 10 broad occupation types. Vertical segregation has evolved through a cluster of women working in lower-level jobs, often low skilled and low paid. Occupational segregation remains one of the strongest influences on young people's choice of career. Girls are still moving into industry sectors such as nursing, teaching and childcare. Boys continue to enter engineering, building services or ICT. Individuals' "life choices" are seriously compromised by occupational segregation; there has been no significant increase of women entering the construction, engineering, plumbing or ICT industries during the past 10 years (EOC, 2004a).
- **Caring Responsibilities:** In the UK women are still shouldering the main responsibility for childcare and increasingly taking the responsibility for the care of their elderly relatives. In these cases, women often have to work part-time, it is impossible for them to work long hours or they take time out of work. These factors contribute to the impact on women's earning power and promotion potential.
- **Discrimination in Pay Systems:** Organisations assume that because they have the same rate of pay for men and women then they have equal pay systems; however, pay systems are extremely complex (Neathey, Dench, & Thomson, 2003). Individualised pay is determined on value judgements and includes bonus schemes and performance-related pay. Women experience pay discrimination due to lower starting salaries, exclusion from bonus schemes, inability to qualify for long service awards and being awarded lower marks in performance assessments.

THE GENDER PAY GAP AND THE UK ICT LABOUR MARKET

On first inspection, ICT *gender pay gap* data gathered from the Office of National Statistics suggest a relatively small pay gap when comparing women's and men's hourly and weekly income (EOC, 2004a). For example, male ICT professionals earn on average £684.80 a week compared to the female ICT professional weekly wage of £619.80.

The figures shown in Table 1 portray the gender pay gap in the UK in a comparatively positive light. IT industry in a comparatively positive light; nevertheless, as most women are positioned at the lower end of the market, we assert that the *gender pay gap* is, in fact, greater than these statistics suggest and that *pay discrimination* is inherent in the ICT sector. There are limitations to statistical data on the "IT labour market"— research suggests that "working in IT" is an extremely difficult and complex sector to define (WINWIT, 2004). There are highly skilled women working in IT departments in many organisations and also in other industry sectors, such as the creative sector with design technologies and in new media industries. Taking this into consideration, we acknowledge that the IT sector is diverse and that much of women's engagement with IT may lay outside the traditional IT sector.

The ESF-funded DEPICT project seeks to investigate issues surrounding equal pay in the ICT sector as a result of the following factors:

- Individualised pay packages are common in the ICT industry, which involves requiring strong individual negotiation skills and a high level of confidence. Women have reported being uncomfortable with this method of pay-and-re-

Table 1. Gender pay gap data from the Office of National Statistics (2003)

	FEMALE		MALE		Gender Pay Gaps	
	Hourly	**Weekly**	**Hourly**	**Weekly**	**Hourly**	**Weekly**
ICT Managers	21.16	784.9	23.69	892.8	10.7	12.1
ICT Professionals	16.35	619.8	17.87	684.8	7.5	9.5
IT strategy and planning	N/A	N/A	22.19	848.6	N/A	N/A
Software professionals	15.20	517.5	16.83	644.5	9.7	11.3
IT Service Delivery Occupations	12.46	463.8	14.65	562.2	14.9	17.5
IT operations technicians	13.14	468.2	15.20	582.8	13.6	16.6
IT user support technicians	10.97	415.0	13.19	507.2	16.8	18.2
Telecommunications Engineers	N/a	N/a	11.89	477.6	N/a	N/a
Computer Engineers, Installation and Maintenance	N/a	N/a	12.16	483.3	N/a	N/a
All Occupations	10.56	396.0	12.88	525.0	18.0	24.6

Source: Office of National Statistics (2003), New Earning Survey

ward negotiation, and find that masculine and aggressive organisational culture mitigates against success in such negotiation (WINWIT, 2004). Moreover, the ICT skills that women possess are often undervalued, marginalised or unrecognised regardless of achievement (WINWIT, 2004; Woodfield, 2000).

- There is a culture of "*salary secrets*" in the IT industry, and women have reported that they only find out about pay inequalities once they reach management level and have access to financial or personnel information. In research analysing gender equality in organisational pay structures and pay practices, including an initial evaluation of Equal Pay Reviews (Neathey et al., 2003), data revealed that more than 1 in 5 employers (22%) did not allow their employees to share information about pay with colleagues. Employers often expect confidentiality about pay and disclosing this information to colleagues can lead to disciplinary action.
- The Women in North West IT (WINWIT, 2004) reported gaps in annual salaries between male and female ICT professionals as much as £17,000. Women were also reported to have experienced discrimination in pay and promotion after returning from maternity leave and choosing to work family-friendly hours.
- Many women with caring responsibilities need to work part-time and this is often incompatible with working in the ICT industry, as part-time working is rarely an option.
- The current pension system operating in the UK is based on full-time, lifetime employment and is excluding workers who work part-time and people whose employment is disrupted by periods of unpaid domestic responsibility, which disproportionately impacts negatively on women (Prosser, 2005).

THEORETICAL FRAMEWORK FOR THE PROJECT

The economic, social and political root of women's inequality in the labour market is a contested theoretical area. This section discusses neo-classical, dual labour market theory and critical approaches to explaining women's inequality at work and the theoretical framework that is shaping this research.

Neo-classical economic theory explains women's pay discrimination in two main ways. First, there is an "individual" explanation suggesting that the wage paid to an individual relates to the value of the output that the individual produces. If women are paid less than men, this must be because the value of what they produce is less; that is, they are less productive (Richardson, 1984). *Human capital* theorists, on the other hand, try to link women's supposedly lower human capital to their role in the family. This view suggests that women have a "free choice" and indeed choose to obtain less education and training, choosing instead the role of child rearing. If women enter the labour market, this choice, therefore, has an impact on pay rewards.

Of course, these views can be criticised for suggesting an innate and rational economic view of the labour market and family relations divorced from actual experience. The state is involved in much of the organisation of the labour market and society through education and welfare policy, for example. Not all women share the same experience and choice of education and training, and such theories are attributing experiences to all women regardless of whether they work or have children.

Such approaches are now finding resonance in theories of the "information society" or "knowledge economy" (in particular, see Castells, 1996). Giddens (1984), concurring with Beck's individual and risk society thesis (Beck 1992), suggests that the changing situation of men and women in the family and at work must be seen in terms of individual choice: "We live in a world in which social order of the nation state, class, ethnicity and traditional family is in decline. The ethics of individual self-fulfilment and achievement is the most powerful in modern society" (Beck, 2002).

Taking a more practical view of the labour market, some theorists view a dual structure at work arising out of the need to cope with consumer and market fluctuations (see, e.g., Barron & Norris, 1976). In this approach, women dominate the secondary sector of employment, involving occupations with greater opportunities for dispensability and gender segregation, which more easily enables discrimination; a more acquiescent workforce because the wage is not always the sole income; and finally, a lack of solidarism because of the scattered nature of these secondary workplaces and preponderance of part-time work. This dual-market structure, therefore, affects women's overall position, and ideological factors both cause and effect women's inferior position within the labour market *and* the family.

Again, stereotypic assumptions form the basis of dual labour market theory (Beechey, 1980). It is implied that domestically women are reliant on men's wages and are only incidentally part of the workforce. This is not the reality for most women or the experience in most households (German, 2003).

Our research is shaped by critical and feminist approaches to understanding women's inequality in the labour market. Critical approaches to women's inequality largely are rooted in Marxist or Feminist theory. Feminist theories often locate women's inequality in patriarchal gender relations within capitalist relations. Women are thus divided along class lines but share the oppression of male domination. Capitalism and patriarchy in this way continually interacts, affecting women's position in the economy and family. This leads to the "economics of male advantage" (Cockburn, 1983, p. 8). In Marxist analysis, women's position in the labour market depends not on market principles, but arises from the organisation of production with roots in class exploitation. Inequality in the labour market is linked to women's oppression in the family. German (2003) explains that the family is both broken down by the effects of capitalism but also maintained and reinforced by capital as the cheapest, most convenient and most socially stable way of caring for the existing generation of workers and reproducing the next generation. The family fulfils too precious a role to be left to "free market" individualism. In reality, three-quarters of households are still headed by two-parent families, and men and women are moving closer together in terms of work and domestic life, but not in circumstances of their choosing. They do so "against a backdrop of continuing women's oppression and intensified exploitation for both men and women" (German, 2003, p. 31). Fitting into these roles is hard work—for women, it means working for less than equal wages and, for men, increased unpaid childcare in the home.

Yet the family is a gendered institution and is often taken for granted. Wharton (2005) describes how the family is viewed as "somehow functional for society rather than a social construction and changing in relation to history and culture" and she continues to observe that though family diversity is a social fact, this is "obscured by a set of taken-for-granted beliefs about the family as a social institution" (Wharton, 2005, p. 105). These include myths of the nuclear family, the heterosexual family, women as mothers and caretakers and men as fathers and breadwinners. However, it is these myths that inform the choices made, including government and employment policies. As Huws (2003) suggests:

... more than this, women's role in the domestic sphere is used to confirm and legitimate their marginal status in the labour market. The gendering of jobs cannot be reduced to a discussion of women in the domestic sphere, but must be seen as arising from the interplay between their socially ascribed, and therefore shifting, roles in both the public and private domains. (2003, p. 28)

RESEARCH METHODOLOGY

The ESF-funded research project DEPICT began in January 2005, with a detailed look at the causes of pay inequality between women and men. Researchers will draw upon expertise from steering committee members made up of representatives from the ICT industry, trade unions, academics, other agencies and upon background material by the *Equal Opportunities Commission* and other related literature.

The research will conduct qualitative research to gather primary data and will conduct in-depth semi-structured interviews with women entering, returning, working in or who have left the sector to ascertain their views and experiences on pay issues. Additionally, the study aims to produce supporting evidence via Web-based quantitative questionnaire that will be publicised on women's ICT forums, the aim of which is to gather data about pay from as many women working in the sector as possible to enhance the understanding of the complexities of the issue.

The project will end in December 2006, when a report will be prepared for the ESF and research results will be disseminated via workshops for organisations, women, local government representatives and other interested parties throughout England.

CONCLUSION

This article provides an overview of current research being undertaken by the ESF-funded DEPICT project at the University of Salford's Information Systems Institute that aims to investigate equal pay issues in the UK ICT sector. Despite 30 years of equal pay legislation in the UK, the gender pay gap still stands at 18%, the main contributing factors being occupational segregation, caring responsibilities and discrimination in pay systems The DEPICT project intends to highlight problems of overt and hidden pay discrimination and explore the implications these issues on have on women's progression and retention in the ICT industry, where women are already severely underrepresented. We present the argument that current data is limited, as the ICT sector is difficult and complex to define. We have presented a contextual theoretical framework for conducting the research by describing human capital theory and the dual labour market theory alongside critical approaches to explain women's inequality at work. The final section indicates a brief overview of the research methods that will be utilised during the research process.

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KEY TERMS

Equal Opportunities Commission (EOC): The EOC is an independent, non-departmental public body, funded primarily by the government. Although independent from the government, they are responsible to the cabinet minister with responsibility for women and equality and to the deputy minister for women and equality in the Department for Trade and Industry.

Equal Pay Act: The Equal Pay Act covers discriminatory contractual terms related to pay and benefits (such as holidays, cars, etc.). The Act was amended by the Equal Pay (Amendment) Act 1983, which stated that men and women should be paid equally for work of equal value to their employers. This intended to tackle the fact that women tend to be occupationally segregated and so often cannot compare "like job with like." The Equal Pay Act only has jurisdiction for jobs done at an establishment within Britain. (The Sex Discrimination Act applies to any non- contractual payments of money or benefits; e.g., a one-off Christmas bonus payment.)

Gender Pay Gap: The gender pay gap is determined by calculating women's overall average pay as a percentage of men's. So, for example, the pay gap is said to be 18% where women's pay is 82% of men's. The gender pay gap is said to "narrow" as women's average pay moves closer to men's. To arrive at a figure for the gender pay gap, most official statistics compare the average hourly earnings of men and women working full-time as the best way to compare "like with like." This accounts for differences in hours worked.

Human Capital: Human capital theory suggests that women are rewarded for their previous investment in their own education and training; women do not receive the same rewards in terms of entry to employment, promotion and levels of pay received as men as a result of "choosing" to invest human capital in labour, such as childrearing.

Occupational Segregation: Occupational segregation is a major cause of the gender pay gap, which currently stands at 18% 30 years after the Equal Pay Act. In the UK, women are concentrated in a limited range of occupation types, predominantly in the lower-paid sectors of employment, such as catering, cleaning and caring.

Pay Discrimination: Since 1975, women and men have had the right to equal pay, but pay discrimination still takes place in many workplaces. Sometimes, women are paid less than men for doing the same job. In other cases, women are paid less than men for doing work of equivalent value for their employer. Both these forms of discrimination may be unlawful. Men paid less than their female colleagues also have a right to equal pay.

Salary Secrets: The "hidden truth" regarding pay inequality between men and women often go unnoticed until women reach senior management levels. Employers often require individual salary levels to be kept confidential.

ENDNOTE

[1] Mean individual income is the average, by calculating the sum of all earnings and dividing the total by the number of employees. However this total can be influenced by very high earnings of a few individuals and can present a distorted view of the "average."

D

Discrimination and Hostility Toward Women and Minorities in the IT Work Force

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INTRODUCTION

There is substantial evidence for a critical shortage of skilled IT workers in the United States (Freeman & Aspray, 1999; ITAA, 2002). From 2000 to 2010, the occupation of computer specialists is projected to grow 69%, and the occupation of computer and information systems managers is projected to grow 48% (Hecker, 2001). Although demand for IT workers dropped in recent years (5% alone in 2001, ITAA, 2002), there is still a lack of *qualified* workers, referred to as the "gap" in IT workers. A large subset of this problem is the under representation of women and minorities in the IT workforce. It is possible that if women and minorities were represented in the IT workforce (ITWF) in proportion with their representation in the general population, the shortage of IT workers in the U.S. could be solved (CAWMSET, 2000; Freeman & Aspray, 1999). Some preliminary work has been done to identify barriers to the entrance and retention of women and underrepresented minorities in the ITWF (CAWMSET, 2000; ITAA, 2000), such as lack of role models and mentors, exclusion from informal networks, stereotyping and discrimination, an inhospitable atmosphere towards women, unequal pay scales and inadequate work/family balance (CAWMSET, 2000; ITAA, 2000; Panteli, Stack, Atkinson, & Ramsay, 1999).

BACKGROUND

Over the past few decades, there has been increasing recognition of the seriousness of different forms of misogyny and hostility toward women in the workplace (Miner-Rubino & Cortina, 2004). In particular, sexual harassment and its negative effects have received considerable attention (Fitzgerald, Drasgow, Hulin, Gelfland, & Magley, 1997). Until recently, most research on hostility has focused on the direct, active, physical types of hostile behavior that occur in work settings (Neuman & Baron, 1997). More recently, researchers have examined more subtle forms of hostility, such as rude, impolite behavior (Miner-Rubino & Cortina, 2004). Miner-Rubino and Cortina (2004) looked at how working in an organized context perceived as hostile toward women effects employee well-being, even in the absence of personal experience of hostility. Hostility toward women was found to be related to decreased well-being (work satisfaction and withdrawal behaviors) for both female and male employees. Gender discrimination and other forms of discrimination can be categorized into two practices: access and treatment (Levitin, Quinn, & Staines, 1971). Access discrimination emphasizes non-job-related qualifications on individuals, such as gender, race, age, and physical appearance, as limits for recruitment. Treatment discrimination is expressed in salary, job level, and status discrepancies. Treatment discrimination can affect not only tangible phenomena such as possible assignment, training opportunity, salary increase, promotion, termination, and layoff, but also subtle issues as acceptance in a work group or availability of career-enhancing and psychosocial support from supervisors and others (Ilgen & Youtz, 1986).

Based on data collected between 1988 and 1990, Truman and Baroudi (1994) found that access discrimination toward women does not take place in the ITWF, at least not for women at the highest educational levels (bachelor's and master's degrees). They suggested that access discrimination may be occurring at earlier stages (i.e., during the socialization process when women attitudes about appropriate job roles are formed), during the college admission process, or during the educational process. However, they found some evidence for treatment discrimination: women received lower salaries than men even when job level, age, education, and work experience were considered (Truman & Baroudi, 1994). There is relatively little information on access and treatment discrimination of minorities. Greenhaus, Parasuraman, and Wormley (1990) studied the effect of race on organizational experience, job performance evaluation, and career outcomes in a sample of 1628 black and white managers in three organizations. Race was found to have significant effects upon job performance evaluation, career plateauing and career satisfaction. Sanchez and Brock (1996) studied the effects of perceived treatment discrimination in a sample of 139 Hispanic employees. Results showed that a culturally relevant work stressor (i.e., perceived discrimination), contributed to employee outcomes above and beyond other work stressors.

In this article, we focus on unequal treatment, discrimination, and an inhospitable atmosphere towards women and minorities as possible reasons for high turnover of women and minorities in the ITWF. Turnover is highly related to quality of working life (QWL: job satisfaction, organizational commitment, and stress) in the ITWF (Baroudi, 1985; Hoonakker, Carayon, Schoepke, & Marian, 2004; Igbaria & Greenhaus, 1992). Therefore, we also examine the relation between unequal treatment, discrimination and a hostile environment, and QWL.

MAIN THRUST OF THE ARTICLE

Method

Two databases were used in the analyses. The *first database* has data of 624 male and female employees in five IT organizations in the U.S.: one large company (N>500), one medium sized company (N=200) and three small companies (N<100). The *second database* contains data of an international organization of female engineers and scientists employed in the IT field. In this second database, we only use data from 163 women employed in the U.S. Twenty-six cases had missing data on either gender and/or ethnicity1. See Table 1 for data on gender and ethnicity in the study sample.

We developed our own questionnaire based on existing scales; this questionnaire has been shown valid and reliable (Carayon, Schoepke, Hoonakker, Haims, & Brunette, 2006, in press). Two scales measured discrimination/unequal treatment. The first scale is adapted from Sanchez and Brock (1996) and contains two sets of questions. The first set of questions is aimed at personal experience of unequal treatment or discrimination, for example: "Have *YOU experienced* unequal treatment or discrimination at your current workplace on the basis of age, sex, having a family, being pregnant, etc. …" (see Table 2 for all sources of discrimination). The second set of questions asks about unequal treatment or discrimination at the workplace: "Do you believe

Table 1. Total sample by gender and ethnicity

	Men	Women	Total
Majority (White, not of Hispanic origin)	280 (85%)	361 (83%)	641 (84%)
Minority	48 (15%)	72 (17%)	120 (16%)
Total	328 (100%)	433 (100%)	761 (100%)

Table 2. Percentage of employees who have experienced unequal treatment of discrimination

Have *YOU experienced* unequal treatment or discrimination at your current workplace on the basis of:

	Majority		**Minority**		**All**	
	Men	Women	Men	Women	Men	Women
Age (against the young)	4%	6%	6%	10%	4%	7%
Age (against the old)	3%	8%	11%	7%	4%	8%
Sex (against women)	1%	25%	4%	26%	2%	25%
Sex (against men)	3%	0.6%	6%	4%	4%	1.2%
Having a family	4%	13%	2%	11%	4%	13%
Being pregnant	0.4%	5%	2%	4%	0.6%	5%
Favoritism	20%	38%	22%	48%	20%	40%
Race	0.4%	1.4%	9%	24%	2%	5%
Nationality	0%	4%	9%	14%	1%	5%
Color	0.4%	1.4%	2%	20%	1%	4%
English language capability	0.7%	3%	7%	13%	2%	5%
Disability	0.7%	2%	2%	3%	0.9%	2%
Religious orientation	0%	2%	4%	4%	0.6%	2%
Sexual orientation	1.5%	2%	4%	3%	2%	2%
Education level	4%	10%	11%	24%	5%	12%
Temporary employment relationship	3%	6%	4%	14%	3%	5%
Part-time employment relationship	4%	9%	2%	13%	2%	7%

that unequal treatment or discrimination occurs at your current workplace on the basis of: age, sex, having a family, being pregnant, etc. …" (see Table 3). Response categories for both sets of questions are yes/no/not applicable.

The second scale is adapted from Lehto and Sutela (1999) and targets discrimination on the basis of ethnicity and cultural background. Examples of items include: "At work, I feel uncomfortable when others make jokes or negative commentaries about people of my ethnic or cultural background" and "At work, I do not get enough recognition because I am different." Response categories for this scale are: strongly disagree—disagree—neither agree nor disagree—agree—strongly agree—not applicable. Cronbach's α for this scale is 0.95.

To measure the general atmosphere towards men, women and minorities in the work environment, we used six dimensions adapted from Fiedler (1967), such as unfriendly/friendly and hostile/supportive (see Figure 1). Respondents were asked to rate the general atmosphere at the workplace towards men, women, and minorities. Three sets of questions were asked, such as: "Describe the general atmosphere in your company for female IT workers (male IT workers and minority IT workers): 1 unfriendly—8 friendly; 1 hostile—8 supportive etc. …". *The general atmosphere scale was only used in the second sample of female scientists and engineers*. Reliability Cronbach α scores are 0.97 for the scale for atmosphere towards women, 0.95 for the scale atmosphere towards men, and for 0.98 for the scale of atmosphere towards minorities.

For a description of the measures of Quality of Working Life (QWL), see Carayon et al. (2006). Turnover intention was measured with a single item: "How likely is it that you will actively look for a new job next year" on a 7-point scale ranging from 1: not at all likely – 2-3: somewhat likely – 4-5: quite likely – 6-7:extremely likely (mean = 2.87, sd = 1.83). The QWL scales and the item on turnover intention were used in both databases. *All scale scores and the item on turnover intention have been recoded to scores between 0 (lowest) and 100 (highest).*

Results

Unequal Treatment or Discrimination

Table 2 shows the percentage of employees who have *personally* experienced unequal treatment or discrimination on the basis of several factors.

Results show that the form of unequal treatment or discrimination most often experienced personally by all respondents is favoritism. Both white women and women belonging to minority groups have more often personally experienced favoritism than men.

Unequal treatment on the basis of gender is the second most often experienced form of unequal treatment: about 25% of women have experienced unequal treatment on the basis of gender. Unequal treatment on the basis of having a family and educational level are other forms of unequal treatment that respondents report having experienced. Unequal treatment on the basis of race, nationality, color, disability, religious orientation, and sexual orientation has been less often experienced by the respondents.

Table 3 shows the percentage of respondents who report that unequal treatment or discrimination occurs *at their workplace*.

Results show again that the most frequent form of unequal treatment at the workplace is favoritism. Interestingly, both minority and majority men think that it occurs less often than women. About 1/3 of the women believe that unequal treatment or discrimination occurs at the workplace on basis of gender, as compared to 8% of the men. Minorities believe that unequal treatment or discrimination on the basis of race takes place at the work place. Both men and women, and minorities and majorities believe that unequal treatment or discrimination on basis of educational level takes place at the workplace. Women (26%) report this type of discrimination significantly more than men (13%).

Discrimination Based on Ethnicity/Cultural Background

Respondents were asked questions about discrimination based on ethnicity and cultural background. Table 4 shows the results of the scale scores by gender and minority status.

A univariate analysis of variance shows a significant gender effect ($F=37.3$, $p<0.001$), a significant minority/majority effect ($F=11.7$, $p<0.001$) and a nearly significant interaction effect ($F=3.5$, $p=0.06$). Women feel significantly more discriminated against than men; minorities feel more discriminated against

Table 3. Percentage of respondents who report unequal treatment or discrimination at their workplace

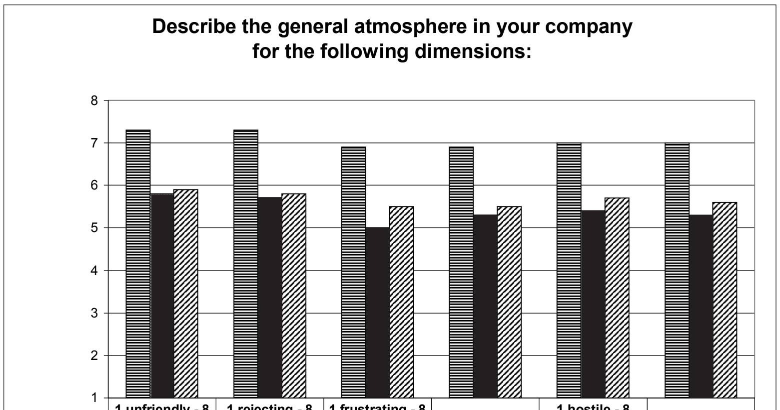
Do you believe that unequal treatment or discrimination occurs *at your current workplace* on the basis of:

	Majority		**Minority**		**All**	
	Men	Women	Men	Women	Men	Women
Age (against the young)	7%	9%	4%	17%	7%	10%
Age (against the old)	10%	21%	9%	27%	10%	22%
Sex (against women)	7%	32%	13%	41%	8%	33%
Sex (against men)	5%	2%	6%	6%	5%	2%
Having a family	7%	23%	4%	10%	7%	21%
Being pregnant	4%	17%	2%	14%	4%	16%
Favoritism	32%	51%	25%	56%	31%	51%
Race	5%	14%	22%	31%	7%	17%
Nationality	5%	12%	16%	23%	7%	13%
Color	4%	11%	19%	28%	6%	14%
English language capability	14%	19%	15%	29%	14%	21%
Disability	4%	8%	2%	17%	4%	10%
Religious orientation	1%	4%	6%	7%	2%	4%
Sexual orientation	3%	7%	11%	11%	4%	8%
Education level	13%	24%	15%	33%	13%	26%
Temporary employment relationship	8%	14%	2%	17%	7%	15%
Part-time employment relationship	6%	15%	2%	17%	5%	15%

Table 4. Discrimination based on ethnicity/cultural background by gender and ethnicity

	Majority		Minority		All	
	Men	Women	Men	Women	Men	Women
Discrimination	19.2	29.8	22.8	39.9	20	32
All	24.7		33.4		26	

Figure 1. The general atmosphere towards men, women, and minorities



	1 unfriendly - 8 friendly	1 rejecting - 8 accepting	1 frustrating - 8 satisfying	1 cold - 8 warm	1 hostile - 8 supportive	1 unfair - 8 fair
Men	7.3	7.3	6.9	6.9	7.0	7.0
Women	5.8	5.7	5.0	5.3	5.4	5.3
Minorities	5.9	5.8	5.5	5.5	5.7	5.6

than the majority (Whites); and female minorities feel more discriminated against than male minorities.

General Atmosphere in the Company Towards Men, Women, and Minorities

Respondents in the second sample were asked to describe their work environment on six dimensions, such as unfriendliness-friendliness and accepting-rejecting, using a 1-8 scale (1 = negative, 8 = positive) (see Figure 1).

The general atmosphere towards women is perceived as significantly more unfriendly, rejecting, frustrating, cold, hostile, and unfair than the general atmosphere towards men, and also significantly more frustrating, cold and unfair than the general atmosphere towards minorities.

Effects of Discrimination Based on Ethnicity and/or Cultural Background and the General Atmosphere Towards Gender and Ethnicity on QWL and Turnover

In order to study the effects of discrimination on QWL and turnover intention, we divided the sample in two groups using the median score: the first group experiences (relatively) little discrimination, and the second group experiences (relatively) more discrimination. Then, we compared the mean scores of the groups on QWL and turnover intention, using an independent sample T-test. See Figure 2 for the results of this analysis.

Discrimination based on ethnicity and/or cultural background significantly affects job satisfaction, organizational commitment, and stress. Respondents who perceive lower discrimination are significantly more satisfied with their jobs, are more committed to the organization, and suffer less from stress. However, the difference between the groups on turnover intention is not statistically significant.

Table 5 shows the effect of the general atmosphere towards men, women, and minorities on QWL and turnover intention. Using the median score, we created two groups (negative and positive atmosphere). Twenty-one percent of the respondents in the second database belong to a minority group.

Results show that the perception of the female scientists and engineers regarding the general atmosphere towards their male colleagues does not affect QWL and turnover intention. As shown in Figure 1, they perceive the general atmosphere towards men as much friendlier than the atmosphere towards minorities and female employees. It does matter significantly how they perceive the general atmosphere towards women in their organization. If

Figure 2. Effects of discrimination on QWL and turnover intention

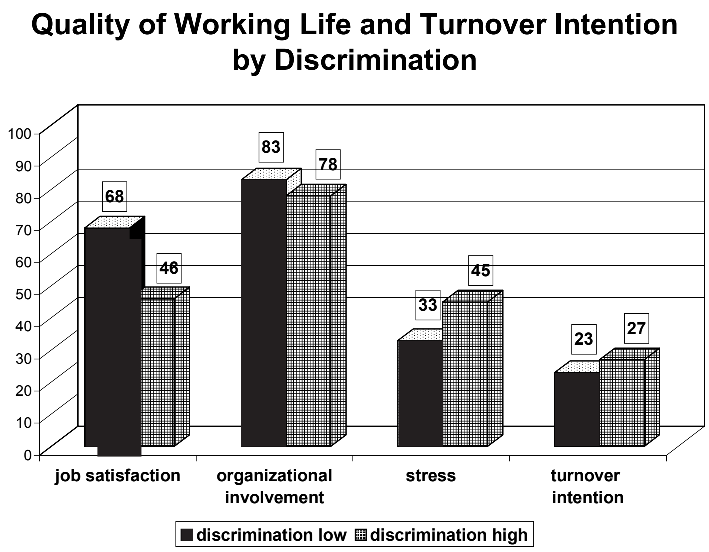


Table 5. Effects of perceived atmosphere towards men, women, and minorities on QWL and turnover intention

	Atmosphere towards male employees		Atmosphere towards female employees		Atmosphere towards minorities	
	Negative (N=74)	Positive (N=84)	Negative (N=83)	Positive (N=80)	Negative (N=76)	Positive (N=56)
Job satisfaction	64	65	53	77***	56	74***
Organizational involvement	86	88	85	88	86	89
Stress	48	48	56	39***	54	40***
Turnover intention	46	46	60	33	57	32

*Note: *** Differences between positive and negative atmosphere are statistically significant at p<0.001*

they perceive the atmosphere as being negative, they report significantly less job satisfaction, more stress, and greater turnover intention. The same holds true for the atmosphere towards minorities. If respondents perceive the atmosphere towards minorities as negative, they report significantly less job satisfaction, more stress, and higher turnover intention.

FUTURE TRENDS

According to statistics from the U.S. Department of Commerce and the Census Bureau, women represent 46% of the total workforce, but only 30% of the IT workforce. Blacks hold only 5% of IT workforce jobs, yet make up more than 12% of the country's population. Hispanics hold less than 5% of IT workforce jobs and make up nearly 12% of the U.S. population. More research and interventions are needed to identify and solve possible causes of the low entrance and retention of women and underrepresented minorities in the IT work force. Especially because the number of women in the IT workforce is dropping and the number of Hispanics in American society is growing rapidly.

CONCLUSION

In this article, we focused on unequal treatment, discrimination, and the general atmosphere towards men, women, and minorities in IT organizations as possible sources of job dissatisfaction and turnover among women and minorities. Results show that unequal treatment and discrimination occurs very often as reported by the study participants. Especially favoritism seems to occur quite often, but also unequal treatment of women and minorities for various reasons. Second, results show large differences in how men, women, and minorities perceive unequal treatment and discrimination in the work place. Women and minorities report that this takes place more often than men. Third, significant differences in the perceived atmosphere towards male and female employees and minorities in IT organizations were found: general atmosphere towards women is perceived as significantly more unfriendly, rejecting, frustrating, cold, hostile, and unfair than the general atmosphere towards men, and also significantly more frustrating, cold, and unfair than the general atmosphere towards minorities.

In addition, discrimination based on ethnicity/cultural background is significantly related to low job satisfaction, low commitment, and high stress, but not related to turnover intention. There may be several explanations for this. First, the impact of discrimination on turnover intention may be moderated by job satisfaction and organizational commitment. Job satisfaction (and to a lesser extent organizational commitment) predict turnover in the ITWF (Hoonakker et al., 2004; Igbaria & Greenhaus, 1992). Another possible explanation is that employees do not expect the situation to be different in other (IT) organizations. A perceived hostile atmosphere towards women and minorities in an organization is significantly related to turnover intention, low job satisfaction, and high job stress, but not related to organizational commitment.

A limitation of this study is that all minorities were grouped into a single category. Obviously, there are many differences between African-Americans, Asians/Pacific Islanders, Hispanics, Native Americans, and other minorities. The minorities are under represented in our sample as they are in the ITWF. Breaking up the group in smaller groups would make our statistical analyses unreliable. However, there is one exception to the under representation of minorities in the ITWF: Asians/Pacific Islanders. Therefore, we looked at possible differences between Asians/Pacific Islanders and other minorities. Results show that Asians/Pacific Islanders report to be as much discriminated against as other minorities. This does not explain the higher entrance rates and retention of Asians/Pacific Islanders in the ITWF. However, additional analyses show that Asians/Pacific Islanders are significantly higher educated than other minorities and whites. For example, in our sample 48% of the Asians/Pacific Islanders hold a graduate or professional degree vs. 31% of the whites and 23% of the other minorities. Apparently, education plays an important role in entrance and retention in the ITWF.

NOTE

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KEY TERMS

Access Discrimination: Places non-job-related qualifications on individuals, such as gender, race, age, and physical appearance among others, that limit or bar their recruitment.

Discrimination: Involves formally or informally classifying people into different groups and according the members of each group distinct, and typically unequal, treatments, rights and obligations.

Gender Discrimination: Can be classified into two practices: access and treatment (Levitin et al., 1971).

IT Organization: Basically, an organization is a group of people intentionally organized to accomplish an overall, common goal or set of goals. An IT organization is an organization where information technology is used to accomplish the common goal or set of goals. This definition is much larger than the definition for IT company: a company that *produces* Information Technology (hardware and/or software). Estimates show that 90% of IT employees are employed in non-IT companies, such as hospitals, banks, insurance companies.

Minority: A group within a country that differs in race, religion, or national origin from the larger part of the population. The following groups are considered minorities in the USA: Afro-Americans; Asians/Pacific Islanders; Hispanics and Native Americans. The majority is White (not of Hispanic origin). Note however, that in the ITWF, Asians/Pacific Islanders are not considered an underrepresented minority. In the ITWF, Asians/Pacific Islanders are relatively overrepresented.

Quality of Working Life (QWL): Represents the quality of the relationship between employees and their total working environment, with human dimensions added to the usual technical and economic considerations.

Treatment Discrimination: Is manifested in salary, job level, and status-symbol discrepancies. Treatment discrimination can affect not only such tangible phenomena as possible assignments, training opportunities, salary increases, promotions, terminations, and layoffs, but also subtle issues as acceptance into a work group or the availability of career-enhancing and psychosocial support from supervisors and others (Ilgen & Youtz, 1986).

Turnover or Labor Turnover: The movement of workers in and out of employment with a particular firm. Labor turnover is typically measured in terms of the separation rate (quits, layoffs, and discharges per 100 employees on the payroll).

Withdrawal Behaviors: Constitutes a cluster of behaviors that reflect attempts to avoid one's work task (e.g., absenteeism; tardiness; missing meetings).

ENDNOTE

1 Note that Asians and Pacific Islanders are not considered an underrepresented minority in the ITWF. However, we have no reason to assume that discrimination based on race, ethnicity, cultural, background and language capabilities does not affect Asians and Pacific Islanders. Therefore, Asians and Pacific Islanders are included in the minority group along with Hispanics and African-Americans.

Diversity in Studying Gender and IT

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INTRODUCTION

Over the past decade, the IS literature has been transformed from one that has virtually ignored gender issues to one in which gender frequently appears center stage. Just 8 years ago, Gefen and Straub (1997, p. 390) noted that "gender has been generally missing from IT behavioral research." Other scholars have also drawn attention to the paucity of gender research in the IS literature even into the 21st century. For instance, Adam, Howcroft, and Richardson (2004, p. 223) noted that "whilst interest in gender has begun to permeate and influence other disciplines, the domain of IS has remained fairly watertight against incursions from gender analysis." In the past few years, however, the IS field has made considerable headway in terms of the number of studies that address gender analyses of IT use and women's experiences in the IT profession. Some advances include special journal issues (Adam, Howcroft, & Richardson, 2002; Gurak & Ebeltoft-Kraske, 1999), an edited book (Green & Adam 2001), and even a focused IS conference track on gender and diversity issues.[1]

This growing interest in the subject of gender and IT has been accompanied by recent claims by scholars regarding appropriate ways to define, conceptualize, and study gender. For instance, the first papers in leading North American journals that prominently featured gender during the 1990s were all quantitative, survey-based studies—either of gender differences in IT use (Gefen & Straub, 1997; Venkatesh & Morris, 2000) or comparative studies of men and women IT employees (Igbaria & Baroudi, 1995; Truman & Baroudi, 1994). Adam et al. (2004) criticized such quantitative approaches to gender in their conceptual review of gender in IS research, noting three shortcomings: Such studies (a) overlook the literature on gender from the social studies of technology field, (b) dichotomize gender into a nominal category, and (c) fail to provide a rationale for why the experiences of men and women differ with regard to IT. They conclude that:

> *... it is the style of explanation that is problematic in these papers. In a nutshell, this research has difficulty explaining the phenomena it apparently uncovers as it does not adequately theorise the construct of gender, nor indeed the construct of technology.* (p. 227)

Their critique of many studies is on target, especially quantitative studies in which the authors neglect to provide insights into factors that shape the different experiences of men and women regarding IT usage or IT-related career experiences. A variety of labels have been employed to describe the underlying logic for why men's and women's experiences and behavior may differ: *social constructivism* (Wilson, 2002), *social shaping* (McKenzie & Wajcman, 1985), *essentialism* (Wajcman, 1991), *feminist standpoint theory* (Harding, 1991), *radical feminism* (Daly, 1992), the *individual-differences perspective* (Trauth, 2002), *gender as performance*, and others. Some of these traditions of scholarship related to gender are more popular in different parts of the world, in different academic disciplines, and at different times in the evolution of various disciplines.

The key message that readers should draw from this critique by Adam et al. (2004) is that all researchers should clearly articulate their conceptualization of gender, including fundamental beliefs the authors hold for what gender means and for why the attitudes, behaviors, and experiences of men and women may be similar to or different from each other. Such articulation of authors' beliefs about gender is highly advantageous—whether their studies compare the beliefs or experiences of men and women, or whether they examine just women (or men) in isolation. Second, I support the advice by Adam et al. that researchers should be cautious about citing certain theories as explanations for differences between men and women whose premises were grounded in an earlier era given that we live "in a world where women make up a much larger proportion of the workforce than when many of the original reference studies were conducted" (p. 228).

On the other hand, it is important that researchers not conclude from their critique of the gender and IS literature that all quantitative, positivist studies of gender and IT are necessarily suspect. I fear, however, that many readers will draw exactly this conclusion. If one were to dismiss all quantitative, positivist studies on IT and gender, this would eliminate nearly 75% of the studies of gender and IT that have been published to date. To reject these studies would, in effect, return us to an era that Adam et al. (2004, p. 223) criticize as being characterized by "difficulties of finding published research on the topic of gender and IS, whether that be interpretivist or positivist in emphasis."

MAIN THRUST OF THE ARTICLE

One common assumption appears to be that quantitative studies that statistically analyze data to identify differences between men and women are misguided because they necessarily assume an essentialist view that that men and women are innately different from each other. While some quantitative scholars certainly subscribe to essentialist beliefs, citing prior literature on innate biological or psychological differences between men and women (as Venkatesh & Morris, 2000, do in citing early research from cognitive psychology), not all quantitative scholars who study gender and IT share such essentialist beliefs. Indeed, researchers who conduct comparative studies need not accept essentialist or deterministic explanations as the underlying reason for the differing experiences of men and women with regard to IT or IT careers. Treating gender as a nominal variable (one that facilitates comparative analysis, whether qualitative or quantitative in nature) is also consistent with a view that gender is socially constructed. For instance, in her qualitative comparative studies of IT use and resistance, Wilson (2004, p. 84) argued that differences between the experiences of men and women are "based on the role of socialization in creating gender difference—rather than ... [different] innate abilities and characteristics." Similarly, Woodfield (2002) also conducted comparative studies of men's and women's experiences in IT careers, offering a social-constructivist explanation for the specific skills and attributes that have been ascribed to women vs. men:

> *My own position on the question of whether women are indeed more socially skilled than men is that women as a group, by dint of their socialisation, are typically more relational in focus, more people-oriented, and often have a more co-operative style of interaction.* (p. 121)

Thus, scholars who conduct comparative studies of the beliefs, actions, and experiences of men and women need not subscribe to essentialist or determinist tenets that men and women are innately different from each other. Of course, researchers who write about gender should clearly explicate their beliefs regarding the meaning of gender and the underlying factors that shape men's and women's experiences regarding IT and IT careers, whether their work is comparative or not. Such scholars may subscribe to essentialist, social constructivist, radical feminist, feminist standpoint, or any of a host of explanations and philosophical traditions regarding the meaning of gender and the reasons for similarities and differences between men and women.

We should be skeptical of all studies that neglect to offer any definition of gender or conceptual basis for the differences they posit between men and women; yet, we must also let the authors speak for themselves rather than draw the unwarranted conclusion that all scholars who analyze comparative, quantitative data on men and women believe in essential, inborn differences between the sexes. Nor should we assume that all qualitative researchers who study gender necessarily assume a social-constructivist perspective on gender. Such views, however, are implied in the statements quoted from Adam et al. (2004), above. As further validation of my argument that quantitative researchers do not all subscribe to essential differences between the sexes, nor do all qualitative researchers hold social-constructivist beliefs, I conducted a literature search of all studies on IT and gender published in the decade from 1994 to 2004. I searched for articles in six online databases that index scholarly IS journals, searching for specific keywords[2] in their titles or abstracts. I found 112 papers published in this interval, with just over half from peer-reviewed journals and the rest from scholarly conferences.

Of this body of work, I classified the papers into five subject areas: 53% of the studies focused on gender issues related to the experiences of IT professionals or students, 31% of the studies examined IT usage and associated user attitudes, 8.5% analyzed gender issues related to computer ethics, 3% analyzed issues related to IT faculty (e.g., hiring practices and publication patterns), and 4.5% considered respondents' attitudes to IT-enabled changes, such as telecommuting, distance learning, and virtual teams. There were also two broad review papers on gender and IS spanning several subjects, which could not be classified into any of the four topics (Adam, 2002; Adam et al., 2004). A total of 110 papers were classified by subject area.

There were a total of 13 conceptual papers, all but two of which articulated the authors' views regarding the underlying reasons for any observed differences between men and women. After removing the two papers spanning multiple subject areas, this left 11 conceptual papers on topics ranging from IT careers (Ahuja, 2002; Kase & Trauth, 2003; Tapia & Kvasny, 2004; von Hellens & Nielsen, 2001) to IT education (Cukier, Shortt, & Devine, 2002), computer ethics (Adam, 2001; Adam & Ofori-Amanfo, 2000), gender issues in designing software (Powell & Johnson, 1995), gender in cyberspace (Westfall, 2000), and the gendered nature of IT in the workplace (Wilson, 2004).

There were 57 studies concerning gender issues related to IT careers or education. Another 33 studies examined IT usage: 27 quantitative studies plus 3 qualitative studies (Kvasny, 2003; McDonough, 1999; Wilson, 2002) and three conceptual studies (Powell & Johnson, 1995; Westfall, 2000; Wilson, 2004). Nine studies examined computer ethics, including seven quantitative studies, two conceptual papers (Alison, 2001; Alison & Ofori-Amanfo, 2000), and no qualitative studies. Finally, there were four additional studies dealing with attitudes toward IT-enabled changes in organizational practices, all quantitative. These studies examined employees' or students' attitudes to telecommuting (Belanger, 1999; Mokhtarian & Bagley, 1998) or virtual teams (Lam & Ching, 2001; Lind & White, 2000).

I classified all empirical studies, first by the five subject areas; second, as qualitative or quantitative; and third, based on the authors' stated rationale for any hypothesized or observed gender differences (essentialism, social constructivism, critical feminism, feminist standpoint theory, etc.). In doing so, I found the seven studies of computer ethics especially interesting. All seven of these quantitative studies (Kreie & Cronin, 1998; Loch & Conger, 1996) stated *a priori* hypotheses regarding gender (e.g., that women would exhibit more ethical behavior regarding software piracy), but none of the authors specifically explained what they meant by gender. They neither explicitly claimed that men and women are innately different due to biological factors, nor did they argue that gender represents a social construction. Due to such ambiguity about the authors' beliefs, I labeled all of these computer-ethics studies as "unclassified".

Of 20 qualitative studies, 8 defined gender and explained the authors' beliefs about the reasons for the observed differences between men and women, yet 12 other qualitative studies neglected to do so. Of 75 quantitative studies, only 4 offered an underlying logic for the different behaviors exhibited by men and women: either essentialism (Venkatesh & Morris, 2000), socially constructed gender schemas (Roldan, Soe, & Yakura 2004), or socialization based on Hofstede's notion of masculine and feminine cultures (Gefen & Straub, 1997; Simon, 2001). All other quantitative studies neglected to define gender or the authors' beliefs about the forces that shape the actions and experiences of men and women.

In terms of lessons that can be drawn from this classification, we see that conceptual studies were much more likely to provide a definition of gender, thus articulating the authors' beliefs regarding the forces that shape the experiences of men and women: 77% of conceptual papers did so, compared to 42% of qualitative, empirical studies and less than 6% of quantitative studies. Thus, the critique offered by Adam et al. (2004) is, in part, supported: Qualitative researchers who study gender and IT are more likely than their quantitative peers to articulate their beliefs about gender, including possible reasons for the different behaviors and experiences of men and women. On the other hand, the implication that quantitative researchers all subscribe to essentialist beliefs appears unfounded: Just one set of authors articulated a definition of gender that could be construed as essentialist, while other authors specified a social-constructivist view (Roldan et al., 2004) or concepts derived from Hosftede's views about socialization into masculine and feminine cultures. Most researchers who published quantitative studies simply compared results for men and women without mentioning their beliefs about gender (whether essentialist or otherwise).

CONCLUSION

Most qualitative and quantitative studies in the IS literature can be criticized on the grounds that their authors neglect to offer any explanation for the hypothesized or observed differences between the men and women they study. It is important for all researchers who study gender and IT to make their beliefs about the reasons for similarities and differences among men and women explicit. This review of 112 published studies reveals that there is insufficient evidence to conclude that most quantitative researchers who conduct comparative studies on gender (i.e., treating gender as a nominal variable by comparing the beliefs and experiences of men and women) subscribe to essentialist notions. This is because 95% of quantitative researchers neglected to specify any grounds for the differences they analyzed. Likewise, most qualitative researchers (60%) also neglected to offer any conceptual basis to explain what they meant by gender or any differences they found between men and women. There is no reason to believe that all or most scholars who conduct quantitative research on gender and IT subscribe to essentialist beliefs. Many of these researchers may strongly believe, like their qualitative peers, that gender is a social construction.

In fact, comparative, quantitative research may support social-constructivist beliefs, as noted by philosopher Janet Wesselius (1998), who argues that treating sex as a nominal category for comparison purposes need not assume underlying essential differences. Rather, Wesselius claims that it is appropriate to consider men and women as distinct categories for purposes of comparison due to what Fuss (1989) labels a *nominal essence*, as opposed to a *real essence*:

> *Real essences refer to the fixed properties of things; nominal essences refer to the way we categorize and label things ... [W]e can recognise that some humans have been assigned a nominal or socially constructed essence as women; that is, women are the same to the extent that they are treated as the same. Women share a common categorization whether or not this is the result of a real essence. By seeing the commonality that women share as a socially constructed essence, we can account for women as a category without suppressing difference [among them].*

There will always be some scholars who believe that men and women are innately different due to inborn factors, and quantitative studies that treat gender as a nominal category are consistent with such views. Yet, such essentialist notions cannot be assumed to characterize all or even most quantitative researchers. Quantitative studies of IT and gender should thus be evaluated on their own merits based on the authors' explicitly stated rationales for their gender beliefs rather than rejected as a whole.

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Powell, P. L., & Johnson, J. (1995). Gender and DSS design. *Decision Support Systems, 124*, 27-58.

Roldan, M., Soe, L., & Yakura, E. K. (2004). Perceptions of chilly IT organizational contexts and their effect on the retention and promotion of women in IT. In *Proceedings of the SIG MIS/CPR Conference* (pp. 108-113).

Simon, S. J. (2001). The impact of culture and gender on Websites. *Database for Advances in Information Systems, 32*(1), 18-37.

Tapia, A., & Kvasny, L. (2004). Recruitment is never enough: Retention of women and minorities in the IT workplace. In *Proceedings of the SIG MIS/CPR Conference* (pp. 84-91).

Trauth, E. M. (2002). Odd girl out: The individual differences perspective on women in the IT profession. *Information Technology & People, 15*(2), 98-117.

Truman, G. E., & Baroudi, J. J. (1994). Gender differences in the IS managerial ranks. *MIS Quarterly, 18*(2), 129-141.

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Wilson, M. (2002). Making nursing visible? Gender, technology and the care plan as script. *Information Technology & People, 15*(2), 139-158.

Wilson, M. (2004). Conceptual framework for studying gender in IS research. *Journal of Information Technology, 19*, 81-92.

Woodfield, R. (2002). Woman and IS development. *Information Technology & People, 15*(2), 119-138.

REFERENCES BY CATEGORY

The following are used to classify studies retrieved from our 1994 to 2004 literature search on gender and IT. Of the 112 studies retrieved from the search, only those studies that are directly referenced in this article are classified below. Interested readers may contact the author for a full listing of studies by their classification.

Conceptual Papers

Essentialist

Powell, P. L., & Johnson, J. (1995). Gender and DSS design. *Decision Support Systems, 124*, 27-58.

Social Constructivist

Adam, A., Howcroft, D., & Richardson, H. (2002). Gender and IS. *Information Technology & People, 15*(2), 94-97.

Adam, A., Howcroft, D., & Richardson, H. (2004). A decade of neglect: Reflecting on gender and IS. *New Technology, Work & Employment*, 222-239.

Tapia, A., & Kvasny, L. (2004). Recruitment is never enough: Retention of women and minorities in the IT workplace. In *Proceedings of the SIG MIS/CPR Conference* (pp. 84-91).

Von Hellens, L., & Nielsen, S. (2001). Australian women in IT. *Communications of the ACM, 44*, 46-52.

Westfall, J. (2000). What is cyberwoman? The "second sex" in cyberspace. *Ethics and IT, 2*, 159-166.

Wilson, M. (2004). Conceptual framework for studying gender in IS research. *Journal of Information Technology, 19*, 81-92.

Critical Feminist

Adam, A. (2001). Computer ethics in a different voice. *Information and Organization, 11*, 255-261.

Adam, A. (2002). Exploring the gender question in critical IS. *Journal of Information Technology, 17*, 59-67.

Adam, A., & Ofori-Amanfo, J. (2000). Does gender matter in computer ethics? *Ethics and IT, 2*, 37-47.

Unclassified

Ahuja, M. K. (2002). Women in the IT profession. *European Journal of IS, 11*(1), 20-34.

Cukier, W., Shortt, D., & Devine, I. (2002). Gender and IT: Implications of definitions. *Journal of IS Education, 13*(1), 7-15.

Kase, S. E., & Trauth, E. M. (2003). Toward a model of women in the IT workplace. In *Proceedings of the 9th AMCIS Conference* (pp. 1559-1567).

Empirical Quantitative Studies

Essentialist

Venkatesh, V., & Morris, M. G. (2000). Why don't men ever stop to ask for directions? Gender, social influence and their role in technology acceptance and usage behavior. *MIS Quarterly, 24*, 115-139.

Social Constructivist

Gefen, D., & Straub, D. W. (1997). Gender differences in the perception and use of email: An extension to TAM. *MIS Quarterly, 21*(4), 389-400.

Simon, S. J. (2001). The impact of culture and gender on Websites. *Database for Advances in Information Systems, 32*(1), 18-37.

Unclassified

Belanger, F. (1999). Workers' propensity to telecommute. *Information & Management, 35*, 139-153.

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Mokhtarian, P. L., & Bagley, M. N. (1998). The impact of gender, occupation, and presence of children on telecommuting. *Journal of American Society for Information Science, 49*, 1115-1134.

Truman, G. E., & Baroudi, J. J. (1994). Gender differences in the IS managerial ranks. *MIS Quarterly, 18*(2), 129-141.

Empirical Qualitative Studies

Social Constructivist

Roldan, M., Soe, L., & Yakura, E. K. (2004). Perceptions of chilly IT organizational contexts and their effect on the retention and promotion of women in IT. In *Proceedings of the SIG MIS/CPR Conference* (pp. 108-113).

Wilson, M. (2002). Making nursing visible? Gender, technology and the care plan as script. *Information Technology & People, 15*(2), 139-158.

Woodfield, R. (2002). Woman and IS development. *Information Technology & People, 15*(2), 119-138.

Feminist Standpoint Theory

Kvasny, L. (2003). Triple jeopardy: Race, gender and class politics of women in technology. In *Proceedings of the ACM SIG MIS/CPR Conference* (pp. 112-116).

Individual Differences

Trauth, E. M. (2002). Odd girl out: The individual differences perspective on women in the IT profession. *Information Technology & People, 15*(2), 98-117.

Unclassified

Craig, A., Scollary, A., & Fisher, J. (2003). Overcoming the adversity of diversity: An Australian story. In *Proceedings of the 9th AMCIS Conference* (pp. 1540-1548).

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Panteli, A., Stack, J., Atkinson, M., & Ramsay, H. (1999). The status of women in the UK IT industry. *European Journal of IS, 8*(3), 170-182.

KEY TERMS

Essentialism: The belief that men and women are innately different due to inborn biological factors.

Feminist Standpoint Theory: The belief that socially oppressed groups (e.g., women and ethnic minorities) can access knowledge that is unavailable to members of socially privileged groups.

Gender as Performance (Performative Theories of Gender): The view that gender is a verb (i.e., gendering or doing gender) and should be analyzed as a process rather than a fixed state.

Individual-Differences Approach: The view that gender is socially shaped, but in distinct ways for each individual, due to the individual's unique history, culture, and personal experiences.

Social Constructivism: The belief that gender is a social convention whereby social norms dictate acceptable attributes and behaviors for men and women, including their choice of careers.

D

ENDNOTES

1. In 2003, the Americas Conference on IS (AMCIS) initiated a track titled *Diversity in the IT Workforce* that has featured over 15 papers to date on topics such as gender and ethnic diversity in IT careers and in IT usage.
2. I searched for studies available through six databases of scholarly journals, published since 1992, focusing on the terms gender, women, female, sex, or, alternately, male and men, in the title or abstract. These six databases represented all electronic resources available through my university's academic library that index scholarly IS journals and conferences: ABI/Inform, ACM Digital Library, AISnet, EBSCo Business Source Premier, Emerald Online, and Science Direct. These sources cover all leading academic IS journals published in North America (e.g., *CACM*, *Database for Advances in IS*, *Decision Support Systems*, *ISR*, *Information & Management*, *Information and Organization*, *IRMJ*, *JASIS*, *Journal of CIS*, *Journal of MIS*, and *MIS Quarterly*) and Europe (*EJIS*, *ISJ*, *IT & People*, *Journal of IT*, *Journal of Strategic IS*). They also cover several leading conferences (AMCIS, ICIS, and ACM Special Interest Group on Computer Personnel). This set of databases, unfortunately, excludes papers from two other academic conferences: The ECIS conference (for which papers are not available electronically) and HICSS (for which conference papers are available electronically, but are not searchable). The conference proceedings of IFIP Working Group 8.2 were manually searched by scanning paper titles and abstracts. Studies that were initially published in conference proceedings and then later in a journal were counted just once.

Earnings of Women with Computer Science or Engineering College Majors

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INTRODUCTION

This short article documents that women with college majors in computer science or engineering earn far more than other female college graduates[1]. This relationship is rarely discussed, as far more emphasis is usually placed on the difference in earnings between women and similarly educated men. While the existence of within-field gender pay gaps is important to monitor, these gaps do not necessarily deter women from entering a field. In fact, previous research finds that gender pay gaps tend to be relatively small among young college graduates with computer science or engineering majors, compared to the gender pay gaps in other fields (Weinberger, 1999, 2005; Weinberger & Joy, 2006). The combination of high average pay and low gender gaps in technical fields translates to particularly strong financial incentives for young women to enter these fields.

The statistics presented here are computed from nationally representative studies of United States (U.S.) college graduates. The first study is based on a sub-sample of 1990 U.S. Census respondents who also completed a detailed survey about their educational attainment in 1993, and were surveyed again in 1999. The second study is based on a representative group of 1992 U.S. high school seniors who were resurveyed in 1999, after most had completed their education. This study includes detailed information about each student, including 12th-grade standardized math test scores. Overall, the estimates presented here suggest that women with computer science or engineering college majors earn 30%-50% more than otherwise similar female college graduates.

BACKGROUND

High pay has been a consistent feature of the labor market for college graduates with majors in computer science or engineering. One government report describes the median salary of new college graduates in different fields for the years 1977, 1980, 1984, 1986, 1990 and 1993. In each of these years, computer science and engineering majors (combined) earned at least 35% more than the typical college graduate (NCES, 1998).

Most studies of gender, pay and college major focus on the fact that few women choose these remunerative college majors. The small proportion of women in mathematical college majors "explains" part of the gender differential in pay among college graduates (Brown & Corcoran, 1997; Weinberger 1998, 1999, 2001, 2005; Weinberger & Joy, 2006). However, a thorough analysis finds that, at age 32, only 20% of the overall gender pay gap is related to gender differences in either pre-college mathematics preparation or college major choices (Weinberger, 2001). Among college graduates, gender differences in college major explain a larger proportion—about one-fourth to one-half of the gender pay gap—with the proportion largest among young, recent labor market entrants (Weinberger 1998, 2005). The proportion of the gender pay gap attributable to differences in college major is larger in 1999 than it was for women the same age in 1989, probably because other factors contributing to the gender pay gap have diminished much more quickly (Weinberger, 2005).

WOMEN WITH COMPUTER SCIENCE OR ENGINEERING MAJORS

Statistics provided in Table 1 show that, at mid-life, women with computer science or engineering majors earn 30%-50% more than the average female college graduate.[2] This is true for representative samples of female college graduates aged 33-52 in either 1989 (Columns 1 and 2) or 1999 (Column 3).

Table 1. Average annual earnings by educational attainment, 1989 and 1999

	1989 Average Annual Earnings College Graduates Ages 33-52	1989 Average Annual Earnings Bachelors Level College Graduates Ages 33-52	1999 Average Annual Earnings Bachelors Level College Graduates Ages 33-52
Women Computer Science Majors	**$44,000**	**$43,000**	**$67,000**
(standard deviation)	(13,000)	(13,000)	(31,000)
Sample size	79	65	118
Women Engineering Majors	**$52,000**	**$48,000**	**$65,000**
(standard deviation)	(23,000)	(14,000)	(30,000)
Sample size	87	63	203
All Women College Graduates	**$34,000**	**$31,000**	**$48,000**
(standard deviation)	(19,000)	(17,000)	(28,000)
Sample size	22066	13293	23931

All samples restricted to white women working at least 35 hours per week and at least 50 weeks per year.
"All Women" statistics computed from 1990 and 2000 Census 1% samples.
1989 statistics by college major computed from the 1993 NSF Survey of College Graduates, merged with 1990 Census responses.
1999 statistics by college major computed from the 1999 NSF SESTAT Survey, matched with the 1993 Survey of College Graduates.

Table 2. Annual 1999 earnings of women with computer science or engineering majors, relative to other female college graduates (ordinary least squares earnings regressions)

	(1)	(2)	(3)
Computer Science or Engineering Major	0.393	0.344	0.347
	(0.091)**	(0.095)**	(0.106)**
Worked 35-39 Hours Per Week			-0.104
			(0.056)
Worked 41-48 Hours Per Week			0.119
			(0.051)*
Worked at Least 49 Hours Per Week			0.158
			(0.040)**
Master's Degree			0.072
			(0.038)
Ph.D. or Professional Degree			0.577
			(0.179)**
12th Grade Math Score (1992)		0.007	0.005
		(0.002)**	(0.002)**
Parent Education Controls?	No	No	Yes
Observations	1100	1100	1100
R-Aquared	0.02	0.03	0.12

These data are from the National Center for Education Statistics National Education Longitudinal Study of 1988 eighth graders.
Sample restricted to white women college graduates working at least 35 hours per week, and at least 50 weeks per year in 1999.

Additional analysis finds that younger women (age 23-32) enjoy a similar advantage, with 1989 earnings \$37,000 for computer science/engineering majors (n=804) compared to \$28,000 for the typical college graduate.[3]

The longitudinal study of 1992 high school graduates provides an opportunity to make a more careful comparison between otherwise similar women. The results of ordinary least squares regressions displayed in Table 2 show that the large earnings advantage enjoyed by women with computer science or engineering degrees is robust to including controls for other observable variables. In this sample, women who majored in computer science or engineering earned 48% more than other female college graduates (Table 2, Column 1).[4] After controlling for 12th-grade math scores, the estimated advantage is still high (41%) (Table 2, Column 2).[5] The very small difference between Columns 1 and 2 results demonstrates that very little of the economic advantage to graduates with computer science or engineering majors is "explained" by this measure of pre-college academic preparation or ability that might be valued by the labor market regardless of the college major chosen. The estimated advantage does not change when controls are added for higher degrees earned, the number of hours worked per week and parents' educational attainment (Table 2, Column 3).[6] These regression results strongly suggest a large, causal relationship between women's choice of computer science or engineering college majors and later earnings.

FUTURE TRENDS

Remunerative careers in information technology fields have been around for a long time. Here is one of my favorite old quotes on the subject, from the 1956 book *The College Girl Looks Ahead to Her Career Opportunities*:

If you like doing the unusual and do not mind being the only woman in your college classroom or at work, and if you have the talent, engineering offers unusually high pay and a variety of interesting jobs in a shortage field. (Zapoleon, 1956, p. 227)

High pay has been a persistent feature of the labor market for women with technical training, and is likely to remain so.

CONCLUSION

The representation of women in computer science and engineering professions is not growing nearly as quickly as in other professional fields. Low pay is certainly not the reason. The statistical analysis presented here documents that both young and mid-career women with college majors in computer science or engineering earn 30%-50% more than otherwise similar female college graduates.

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KEY TERMS

Gender Pay Gap: The percent difference in earnings between men and women with similar characteristics, estimated in an earnings regression.

Longitudinal Study: A study in which a group of people is followed over a period of time.

Observable Variables: Variables for which data are available.

Ordinary Least Squares Earnings Regression: Statistical estimation of a linear model of the relationship between the natural logarithm of each person's annual earnings and observable characteristics that tend to be correlated with earnings.

Representative Sample: A subset of a well-defined population, chosen at random from the full population.

Respondents: Individuals who participated in a survey.

Robust: The answer does not change if the question is framed a bit differently, or if the model is specified in a slightly different way.

Standardized Math Test: A math test for which the distribution of scores is well documented. The scores of individual students on these tests tend to be correlated with later educational attainment and labor market outcomes.

ENDNOTES

1 This material is based upon work supported by the National Science Foundation (NSF) under Grant No. 0120111. The use of NSF data does not imply NSF endorsement of the research methods or conclusions contained in this report. Any opinions, findings and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the NSF.

2 Based on annual earnings of full-time, year-round, white women workers, aged 33-52. (This group includes many women who did not work full-time continuously.)

3 Young women of color also enjoy this advantage, with 1989 average earnings of computer science/engineering majors $37,000 for Asian women (n=59), $35,000 for Hispanic women (n=39) and $33,000 for black women (n=115).

4 The earnings advantage is computed as the exponential of the estimated coefficient minus 1.

5 When this specification is estimated separately for Asian, Hispanic or black women, the estimated advantage to computer science/engineering majors is even higher for each of the three groups, ranging from 50%-65%. Relaxing the assumption of a linear relationship between math scores and earnings has virtually no effect on the coefficient of interest.

6 Parents' educational attainment is coded as the highest level attained by either parent. There are eight levels, including missing information for both parents.

An Economist's Perspective on Women in the IT Workforce[1]

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INTRODUCTION

As a labor economist, my usual role in a discussion of women in the information technology (IT) workforce would be to establish the prevalence of gender differentials in outcomes. Elsewhere in this article, I address the question: Are women who invest time and money to acquire education and training in IT fields able to use their skills, and receive commensurate compensation, in the labor market? Because the answer to this question is simply "yes," I explore a second question in this article: Given that women with computer science and engineering college majors earn far more (on average) than other college-educated women, why do so few choose to pursue this career path? The answer to this question matters both because we continue to puzzle about why women tend to earn less than men and because (as argued so eloquently by Margolis & Fisher, 2002) the kinds of technologies that will be developed will depend on the life experiences and interests of our highly-trained IT professionals.

I approach this research by focusing on the college major choices of young women. While it is possible to enter IT careers through many different avenues, both occupational assignments and provision of on-the-job training result from complex interactions between individual workers and employers. In contrast, college major choices are typically far more unilateral, and tend to precede labor market entry. In my research, comparisons are made between women who choose to major in computer science or engineering and those who make other college major choices.

While it is true that women in computer science or engineering fields tend to earn less than men with the same college major, gender differentials in earnings are a fact of life along other career paths as well. For example, in the most recent year for which detailed information is available, the gender differential in earnings among college graduates in their 30s ranged from 15% to 20% in each of four other broad college major categories[2], compared to only 5% among both computer science and engineering majors (Weinberger & Joy, 2006).[3] The information most relevant to women making their career choices is how the earnings of women in IT careers compare to the earnings of other women. On this measure, college training in IT fields appears to be a sound investment: Women with computer science or engineering majors tend to earn 30%-50% more than otherwise similar female college graduates (Weinberger, in this volume).[4] The economic incentive for women to pursue these careers appears to be quite large. Based on this evidence, the barrier to women's entry is evidently not a lack of lucrative career opportunities.

Yet some kind of barrier clearly exists. Statistics available from the National Center for Education Statistics reveal that while the representation of women is now substantial among new college graduates in many previously male dominated fields, this is not true in either computer science or engineering fields.[5] In 1970, fewer than 10% of new bachelor's degree graduates in business, computer science, engineering or newly graduating doctors and lawyers, were women. Today, women and men are nearly equally represented among new graduates in business, law and medicine. In contrast, fewer than one-third of new computer science graduates, and an even smaller proportion of new engineers, are women. And there has been no obvious trend towards increasing representation of women in these fields in recent years. The research presented in the remainder of this article describes a survey of academically talented young women, asking questions designed to reveal what the operative barriers might be.

E

BACKGROUND

Opinions on the reasons for women's underrepresentation in science and engineering fields are varied. At one extreme, Gelernter (1999, pp. 11-12) opines that "The real explanation is obvious: Women are less drawn to science and engineering than men are … Women are *choosing* not to enter, presumably because they don't *want* to; presumably because (by and large) they don't like these fields or (on average) don't tend to excel in them, which is nearly the same thing." This perspective is not universal. Referring to the already highly selected population of M.I.T. science students she teaches, Hopkins (1999, p. 5) observes that "… although scientific talent and brilliance are equally distributed between the sexes, the career prospects for men and women are not equal." The contribution of social scientists to this debate is to take a step back from conclusions based on the people we happen to meet or presume to understand, and examine relationships between gender and career outcomes in randomly selected samples of well-defined populations.

Research based on representative samples of high school students followed to adulthood establish that, conditional on observable measures of academic talent and preparation, young women are only half as likely as young men to pursue science or engineering careers (Xie & Shauman, 2003).

Possible explanations for this difference abound. A growing body of evidence suggests that many women who intend to pursue higher education or careers in science, engineering or information technology fields find a less than welcoming atmosphere in both the university and the workplace (Keller, 1977; Tobias, 1978, 1990; Hall & Sandler, 1982; Gornick, 1983; Zuckerman, 1992; McIlwee & Robinson, 1992; Seymour & Hewitt, 1997; Schiebinger, 1999; Wyer, Barbercheck, Giesman, Ozturk, & Wayne, 2001). Economists tend to focus on explanations based on gender differences in the allocation of time between the labor market and childrearing, hypothesizing that women might prefer to prepare for careers in which labor force interruptions or reduced hours of work per week are less costly (Blakemore & Low, 1984; Polachek, 1978, 1981). A more recent economic analysis focuses on the possibility that women who make gender-atypical career choices might face social sanctions (Badgett & Folbre, 2003).

WHY DO WOMEN AVOID IT COLLEGE MAJORS?

Despite the proliferation of opinions and possible explanations, there is very little evidence on the actual tradeoffs considered by young women as they make their career choices. In a recent mail survey, I asked representative samples of college students at two very different institutions about their reasons for avoiding computer science, computer engineering, and electrical engineering, and other courses and careers. The format of the survey was a list of statements ("I would not choose the majors I have checked below because …" or "I would not choose the career paths I have checked below because …"), where each statement was followed by an alphabetical list of possible college majors or occupations. The results from the first institution are published elsewhere (Weinberger, 2004), while the very similar results for a group of surveyed students at the second institution are presented here, in Tables 1 and 2.

The sample of 195 women described here is representative of all female seniors at the University of Minnesota who were enrolled in a school other than the Institute of Technology and had enough credits to graduate at the time of the survey (Spring 2004).[6] While we focus here on reasons given for avoiding IT courses and careers, the survey was constructed to give no special emphasis to any particular career path. All choices were presented in a neutral way (alphabetically) and no reference was made to IT careers within the survey, cover letter or instructions.

Nonetheless, the women in this group were likely to say that they would avoid IT courses and careers for each of several reasons. The patterns of responses are very similar to those obtained in all three samples examined previously: women in majors chosen by more women than men, women with very high math SAT scores in the same set of majors, and women in the business economics major, all of whom were seniors at University of California—Santa Barbara (Weinberger, 2004). The sample described

Table 1. Proportion indicating "I would not choose the majors I have checked below because …"

Random sample of 195 female graduating seniors enrolled in University of Minnesota schools other than the Institute of Technology

	Biology	Computer Engineering	Computer Science	Economics	Elementary Education	Electrical Engineering	English	Finance	Nursing	Psychology	Sociology
"… the coursework is too time-consuming"	0.3	**0.4**	**0.3**	0.1	0.0	**0.4**	0.1	0.1	0.2	0.0	0.0
"… the courses are too difficult"	0.3	**0.6**	**0.5**	0.2	0.0	**0.6**	0.0	0.2	0.1	0.0	0.0
"… the courses are not interesting to me"	0.4	**0.9**	**0.9**	0.6	0.2	**0.9**	0.3	0.6	0.3	0.1	0.2
"… I would not develop my full potential"	0.3	**0.4**	**0.4**	0.3	0.3	**0.4**	0.3	0.4	0.2	0.2	0.3
"… the subject matter will be quickly outdated"	0.0	**0.3**	**0.3**	0.1	0.0	**0.1**	0.0	0.0	0.0	0.0	0.0
"… I would be considered too serious, nerdy or strange"	0.1	**0.1**	**0.2**	0.0	0.0	**0.1**	0.0	0.0	0.0	0.0	0.0
"… I could not find a job that paid well after graduation"	0.1	**0.0**	**0.0**	0.0	0.3	**0.0**	0.4	0.0	0.0	0.3	0.4
"… I would not be prepared to do socially useful work after graduation"	0.1	**0.3**	**0.2**	0.1	0.0	**0.2**	0.2	0.1	0.0	0.0	0.1
"… employers would assume I was not capable of completing a more challenging major"	0.0	**0.0**	**0.0**	0.0	0.1	**0.0**	0.2	0.0	0.0	0.1	0.2
"… I wouldn't expect the classroom atmosphere to be welcoming to me"	0.0	**0.4**	**0.3**	0.1	0.0	**0.4**	0.0	0.1	0.0	0.0	0.0

Table 2. Proportion indicating "I would not choose the career paths I have checked below because …"

Random sample of 195 female graduating seniors enrolled in University of Minnesota schools other than the Institute of Technology

	Accountant	Computer Engineer	Computer Programmer	Electrical Engineer	Lawyer	Nurse	Pediatrician	Psychologist	Social Worker	Surgeon	Teacher	Tech Support
"… the pay would be too low"	0.0	**0.0**	**0.0**	**0.0**	0.0	0.1	0.0	0.1	0.4	0.0	0.4	0.3
"… I would not enjoy the work"	0.8	**0.9**	**0.9**	**0.9**	0.4	0.3	0.2	0.2	0.2	0.4	0.1	0.8
"… these careers would require too many years of schooling"	0.0	**0.1**	**0.1**	**0.1**	0.4	0.1	0.5	0.2	0.0	0.6	0.0	0.0
"… I could not pass the courses"	0.1	**0.4**	**0.4**	**0.4**	0.2	0.1	0.2	0.0	0.0	0.3	0.0	0.1
"… these jobs require working long hours per week"	0.1	**0.1**	**0.1**	**0.0**	0.5	0.2	0.3	0.0	0.1	0.5	0.1	0.1
"… the work would not be meaningful to me"	0.7	**0.8**	**0.8**	**0.7**	0.2	0.1	0.0	0.0	0.0	0.1	0.0	0.7
"… if I took time off to care for young children, my skills would be out of date"	0.1	**0.4**	**0.5**	**0.2**	0.1	0.1	0.1	0.0	0.0	0.2	0.0	0.3
"… it would be hard for me to 'fit in' with my co-workers"	0.2	**0.4**	**0.4**	**0.4**	0.1	0.1	0.1	0.1	0.0	0.1	0.0	0.3
"… the work would not be socially useful"	0.2	**0.3**	**0.3**	**0.2**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
"… it would be difficult to combine these careers with raising a family"	0.1	**0.1**	**0.1**	**0.1**	0.4	0.1	0.2	0.1	0.1	0.5	0.0	0.1
"… I wouldn't expect the workplace atmosphere to be welcoming to me"	0.1	**0.4**	**0.3**	**0.4**	0.1	0.0	0.0	0.0	0.0	0.2	0.0	0.2

here is different because it is larger and is representative of the entire graduating class of young women at an institution with nearly every possible college major available.

As in the previous samples, almost none of the women in this sample were concerned that they would not be able to find a job that paid well if they choose an IT college major or occupation. These students correctly perceive that computer and electrical engineering jobs are remunerative. There is also little support for other explanations suggested by economic models: Very few women are concerned with social sanctions for choosing IT majors, or express concern that IT careers would require working long hours per week or be difficult to combine with raising a family. In fact, the career paths that were perceived as difficult for mothers (lawyer and doctor) are exactly those in which women have become increasingly well represented in recent years. This is clearly not the barrier to women's entry into IT careers. There was some support for the notion that IT careers are incompatible with taking time out of the labor market altogether (as opposed to working, at least part-time, while parenting), but the surveyed students evidently did not expect this to make IT careers difficult to combine with parenting.

In contrast to the low levels of concern about these economic factors, 30%-40% of the women indicated an expectation that the classroom and workplace atmosphere in IT would not be welcoming to women, or to them personally. Similar levels of concern were reported for each of the three samples in Weinberger (2004), including the sample of women with very high math SAT scores. Concern about climate was not highly correlated with lack of interest in IT careers in any of the samples. Although not the majority of women, it is striking to find higher levels of concern about climate in IT than in medicine, law or finance.

Previous results that IT courses are considered to be both more time-consuming and more difficult than other college courses were also replicated here. One of the most surprising earlier findings is that young women were more likely to indicate that "the coursework required would be too difficult" when asked about IT careers than when asked about a career as a surgeon. Finding it incredible that a bachelor's degree in computer science could be perceived as more difficult than training to be a surgeon, I rephrased the question for the new survey. The question (and responses) were similar in the first section of the survey. As before, 50%-60% of students checked computer engineering, computer science and electrical engineering when prompted with: "I would not choose the majors I have checked below because the courses are too difficult." In the second section of the survey, the prompt: "I would not choose the career paths I have checked below because the coursework required would be too difficult" was replaced in this version by "…because I could not pass the courses." This change in wording was chosen to eliminate those who simply believed the courses were too difficult to bother with, given their level of interest. As expected, students tended to be less likely to believe they would fail than to think the courses were too difficult. However, the surprising result persisted. Forty percent of the women at this selective university believed that they could not pass the courses required for careers in computer engineering, computer programming or electrical engineering. Again, this coursework was perceived as more difficult than that required to become a surgeon.[7]

The question for which the change of venue seems to have had the largest effect is "I would not choose the majors I have checked below because I would not be prepared to do socially useful work after graduation." More women were concerned about this in the Minnesota sample, with 20%-30% indicating this concern about IT college majors. For this version of the survey, the question "I would not choose the career paths I have checked below because the work would not be meaningful or socially useful" was divided into two separate questions ("… would not be meaningful to me" and "… would not be socially useful"). Again, 20%-30% were concerned about the social usefulness of IT careers, but fully 70%-80% indicated that this work would not be personally meaningful.

FUTURE TRENDS

It seems that a vast majority of the women in the sample (90%) would agree with Professor Gelernter that they would not be interested in the courses and would not enjoy the work associated with courses or careers in computer engineering, computer science or electrical engineering. This finding suggests it is vital that we try to understand the mechanisms underlying interest formation if we are to understand the processes leading to this self-selected segregation.[8] It is also important to learn whether it is something intrinsic to these technical subjects, or only the evolved culture surrounding them, that young women find uninviting.[9] This line of inquiry is, in fact, particularly important if it is the case that women have different interests and life experiences than men. For this is exactly the circumstance in which it is important that women's voices be heard when decisions are made about which potential technologies can be developed to best serve the public good.

Just as the federal government sponsors research to understand the fundamentals of good nutrition and informational campaigns to encourage people to eat more fresh vegetables, there is a role for government to support research and policy to foster healthy professional development. And just as my grandmother and mother selected recipes from other cultures that made vegetables more appealing and healthier, there is a role for families here as well. As a research community, our role is to provide reliable information to young people who have the capability to contribute to society in ways they might not have imagined for themselves.

CONCLUSION

Economic considerations do not appear to be the operative barrier preventing surveyed women from choosing college majors or careers in computer science, computer engineering or electrical engineering. Instead, female college students express lack of interest, expectations of not being welcome and seemingly inflated evaluations of the difficulty of college coursework in these fields. These findings point to future research on the process of interest formation, efforts to improve (or change perceptions of) classroom and workplace climates for women, and systematic evaluation of the actual and perceived difficulty of teaching technical subjects to academically high-achieving women. The potential benefits include a future pool of talented, well-trained IT decision makers with a wider range of perspectives than are currently represented.

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KEY TERMS

Earnings Regression: Statistical estimation of a linear model of the relationship between the natural logarithm of each person's annual earnings and observable characteristics that tend to be correlated with earnings.

Gender Differential in Earnings: The percent difference in average annual earnings between men and women with similar characteristics, estimated in an earnings regression.

Highly Selected: A group of people not representative of the entire population, because entry into the group is contingent on stringent selection criteria.

Math SAT Score: The score on a test widely used for college admissions. This score tends to be correlated with the probability of entry into training for technical fields.

Occupational Assignments: The outcome of a process by which individuals are matched with jobs.

Remunerative: Pay well.

Representative Sample: A subset of a well-defined population, chosen at random from the full population.

ENDNOTES

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the research methods or conclusions contained in this report. Any opinions, findings and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the NSF.

2 The categories were Business, Social Science/Humanities, Math/Science and Education. These earnings regressions controlled for differences in hours worked per week, full- and part-time work experience, geographic region, parents' educational attainment and detailed college major within each category. Sample sizes ranged from 700 to 3,500.

3 To read more about gender differentials in pay among the highly educated, see Brown and Corcoran (1997), Weinberger (1998, 1999, 2001, 2005).

4 This brief piece cannot adequately address interactions between college major choices, race/ethnicity and labor market outcomes. For a thorough analysis of this question, see Weinberger and Joy (2006).

5 See http://nces.ed.gov/edstats/

6 Mail surveys were sent to 20% of all second-semester seniors. The response rate for women was just more than 40%. The women described here were enrolled in the Colleges of Liberal Arts (n=108), Biological Sciences (n=12), Management (n=13), Education (n=17), Nursing (n=24) and the college formerly known as Home Economics (n=21). Seniors were sampled because this survey is part of the larger College and Career Choices Study, designed to follow these students into the labor market.

7 As in Weinberger (2004), the corresponding sample of men perceived the coursework required to become a surgeon as more difficult than that required for any of these IT career paths.

8 Research on this topic by Jaquelynne Eccles is in progress.

9 See Seymour & Hewitt (1997), and Margolis and Fisher (2002), for thoughtful treatment of this subject.

E

E-Empowerment through Strengthening Women's Policy Issues via the Internet

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INTRODUCTION

Both Internet studies and women's and gender studies formulated various hopes and fears for the effects of the Internet on gender relations at an early point. Whereas some scholars saw it as a male domain, others pinned hopes for overcoming dichotomous gender constructions to the new technology. The Internet was also seen as an opportunity to network women's policy activists and to strengthen women's policy issues from the very beginning.

There have, however, been few studies of how women specifically use the Internet to further feminist issues. This article addresses this question of Internet use in women's policy networks based on an empirical study, which examined the democratizing use of the Internet for German women's networks. We start off by signifying the importance of the Internet within the developments of the women's movement and giving an overview of the existing research findings. We then analyze the use of the Internet within women's policy networks, using the three dimensions "information", "interaction," and "political action". We wind up the article by outlining an idea that could be used to better concentrate and structure existing Internet services, possibly strengthening women's public political spaces.

BACKGROUND

From its very beginnings, the Internet has been a space for feminists to network and hold discussions: Professional organizations of and for women use the Internet to call attention to women's underrepresentation in technical and scientific occupational areas and to publish background material on the gender-hierarchical division of labor. Women suffering from specific illnesses or with experience of violence can find help and opportunities for exchange via virtual self-help organizations. Women network on an international level via mailing lists on various subjects, such as development policy or breaches of human rights. Cyberfeminists deconstruct the social category of woman with subversive irony and humor, and experiment with new identities in a variety of ways. These and many other pieces of the jigsaw fit together to indicate the broad-based professional and voluntary work of diverse women on the Internet, who are often also active outside of the net in informal networks or established organizations. The Internet appears to offer a wide variety of potentials for women's policy activities.

This diversity cannot, however, be taken for granted, as women's policy activists have been under increasing pressure to justify their activities and standpoints since the last decade of the 20th century. Whereas discrimination against women as a whole was undisputed within the women's movements of the industrialized nations in the 1970s, this view is no longer universally accepted today.

Two developments in particular are behind this change:

- In the industrialized nations, an increasing number of women are being integrated into the labor market. Young women and men have reached an equalized educational level to a major extent, lifestyles are becoming increasingly pluralized, and young women frequently take the existence of equality for granted in these countries.

- Simultaneously, the theoretical discussion on the category of gender has changed direction. Since the mid-1980s, discussion has clearly refocused on the differences *between* women. The call to integrate further axes of inequality alongside gender—such as class, race, and sexuality—that accompanies this development has made it more difficult to justify and realize women's policy activities, despite leading to important new insights.

In this situation, which has led to feelings of uncertainty among those interested and active in women's policy, the Internet provides new spaces for experimentation, which women's policy activists from various types of organizations, associations, and networks use for their very diverse concerns. The new medium appears to be ideally suited to today's age of new disorder, characterized by multiple experiences of discrimination that cannot always be precisely assigned to a specific group.

LITERATURE REVIEW

Since the 1990s, gender and Internet studies have addressed the extent to which the Internet as a technology is a relevant to women or gender and can set gender hierarchies in motion. We can distinguish three positions:

1. **The Internet as a Male Domain:** One significant thread of research on the subject of Internet and gender aims to reveal male dominance on the net. Early studies in particular on access, gender-specific matters of use and communication, and the content of the net come to the conclusion that the Internet is predominately androcentric and, like the "real world", steeped with inequalities and power relationships (Herring, 1996; Spender, 1995). More recent studies, however, show that gender-specific differences have less influence on the digital divide than differences in the factors of age, education and profession (DiMaggio & Hargittai, 2001; Winker, 2005).
2. **The Internet as a Space for Deconstructing Dichotomous Gender Conceptions:** At the same time, feminists have developed utopian visions of a world beyond dichotomous concepts of gender. The possibility of "gender swapping" on the Internet prompted hopes that identities could be constructed in diverse ways (Bruckman, 1993; Turkle, 1995). Cyberfeminists retell the story of technology and gender, interpreting the net as feminine (Plant, 1997), and experiment with gender stereotypes in a playful, joyful, and artistic way (Hawthorne & Klein, 1999).
3. **The Internet as an Opportunity for Women's Policy:** The third thread in the feminist debate on the Internet consists of expectations that women could make use of the Internet to further their own issues and interests. Feminists see new possibilities for networking common interests and for publicizing these subjects (Consalvo & Paasonen, 2002). Feminist discourses also express expectations of building solidarity and communities (Shade, 2002) and worldwide access to diverse knowledge (Floyd, Kelkar, Klein-Franke, Kramarae, & Limpangog, 2002; Harcourt, 1999). However, Shade (2002) and others warn women not to overestimate the Internet. She points out that, although the Internet does offer a variety of opportunities for women's participation in many areas of society, very many women (and men) are also excluded from the net due to both technical requirements (knowledge and availability of hardware and software, lack of infrastructure such as telephone lines and connections in "third world" countries) and socio-economic conditions.

E-EMPOWERMENT

Prognoses, hopes and fears have dominated research to date. There have been very few systematic surveys on how the Internet's possibilities and the new scope for action emerging for political work are utilized and adopted in the context of gender or women's policy issues. The empirical study "E-Empowerment: Use of the Internet in Women's Policy Networks" tackles this research gap, asking to what extent the new medium is used by women's policy activists in Germany for empowerment, in the sense of strengthening their own power and influence.

The study uses various methods:

- Analyses of the Internet presences of 200 German women's networks
- Qualitative interviews with 20 women's policy activists on their use of the Web
- Log-file analyses regarding individual search strategies and the findability of women's networks
- Future workshop conducted online with female Internet experts, on possibilities of networking women's policy organizations via the Internet in the future.

The study is limited to German women's networks and was carried out between 2001 and 2004. It was funded by the German Federal Ministry of Education and Research. As well as analyzing the existing situation regarding the Internet in women's policy networks, it developed practice-related suggestions for designing Internet services for women's policy networks that can be used by as many women as possible and support their political participation (Schachtner & Winker, 2005).

The terms *women's policy networks* or *political women's networks* are used as generic terms for various types of groups of women, regardless of their specific form of organization—from women's associations and political parties to autonomous women's projects or self-help groups with informal organizational forms.

The term *empowerment*, first coined by Rappaport (1984), is closely linked to the U.S. civil and women's rights movements. Through cooperation, people in marginal positions can use and develop their own sources of power to gain greater self-determination and control over their own lives. Empowerment also refers to collective political self-organization, enabling disadvantaged sections of the population to articulate their interests, participate in political processes and gain power. The concept of empowerment not only criticizes existing power relationships, but also demonstrates perspectives for change.

Strengthening Subaltern Counterpublics via the Internet

In order to systematically examine the use of the Internet for women's political interests and the significance of women's policy activities on the Internet, we must compare the objectives and interests of women's policy networks with the functions of the Internet.

Nancy Fraser (1997) describes political women's networks as subaltern counterpublics. According to Fraser, subaltern counterpublics are, firstly, "parallel discursive arenas where members of subordinated social groups invent and circulate counter discourses, which in turn permit them to formulate oppositional interpretations of their identities, interests, and needs" (p. 81). Secondly, Fraser describes subaltern counterpublics as functioning as their participants' own spaces, enabling withdrawal and regrouping, and, thirdly, as capable of changing socio-political reality by influencing discourses and norms in larger, hegemonic publics.

The Internet can further the three aims of subaltern counterpublics named in the previous paragraphs. These objectives can be classified into the three dimensions of "information", "interaction", and "political action". Figure 1 shows how women's policy issues can be strengthened via the Internet.

Figure 1. Strengthening subaltern counterpublics through women's policy Internet presences

Aims of women's policy networks (Fraser, 1997)		
Development of oppositional interpretations of identities and interests	Creation of spaces that allow withdrawal and re-groupment	Representation of interests outside their own spaces and exerting influence in larger arenas
↓	↓	↓
Internet functions for promoting the aims		
Information	Interaction	Political Action
Publishing orientation knowledge Findability via search functions and links Cooperative provision of information	Forums and chatrooms for exchanging and developing problem-solving skills	Preparing and carrying out political activities on the net: - planning actions - signature lists - online polls

Information

Women's policy networks address social problems. Described in terms of Fraser's analytical framework, these networks develop interpretations of identities and interests in opposition to the hegemonic discourse and offer new frameworks and meanings for social reality.

On the net, information can be made transparent and accessible extremely quickly. By using and appropriating the Internet, women's policy networks can publish knowledge, which can then reach a larger circle of interested women. Feminist discourses can be made accessible to a wider public, and possibilities for finding this information can be improved by search functions and links. Networks can refer to each other and bundle their resources. Finally, they can offer information co-operatively, (i.e., by using tools in which every network can enter information on a common platform).

Interaction

At the same time, women's policy networks have the function of creating spaces for withdrawal and regrouping and using them to communicate about their issues and interests outside the hegemonic discourse. Within these spaces, they consult and encourage each other and exchange experiences.

Internet services such as forums and chatrooms simplify communicative exchange between women's policy activists. Such services can improve the flow of information between women, support discussions, and act as a means to develop joint solutions to problems. Further, they allow users to question hegemonic norms or create new norms. Fraser's spaces for practicing political activities can be created in interactive forums and chatrooms; the results of these interactions in Internet-based forums can then be transferred into larger arenas. Communication on the Internet is a valuable addition to traditional forms of discussion, due to its greater flexibility with regard to time and space.

Political Action

Finally, aside from addressing problems within society and communicating on these problems in small groups, the goal of subaltern counterpublics is to represent their interests outside their own spaces. Fraser describes this as their main emancipative potential, because they are able to change political reality by influencing discourses and norms in larger public spaces.

The new technologies offer opportunities for larger groups to participate in political activities. The Internet can be used as a platform to plan joint political actions and to call for participation (e.g., signature lists). In this way, more effective and outwardly perceivable publics can arise.

EMPIRICAL FINDINGS

The research project "E-Empowerment. Use of the Internet in Women's Policy Networks" studied these functions in the three areas of "information", "interaction", and "political action", using the research methods described above.

Information

Our findings indicate that the clear focus of the Web sites of German women's networks is currently on providing information. The networks present themselves on the Web sites, give information on upcoming events, and provide background material on their subjects. At the same time, interviews with women's policy activists confirm that these women use the Internet primarily for searching for information. Women's policy experts use the net to search for academic texts, information on current political discussions and specialized women's policy subjects from their working areas, as well as for organizational support for their everyday tasks.

Thus, the women's policy networks use the medium of the Internet in the same way as they use the traditional media, especially for the purpose of public relations. A wide spectrum of specialized knowledge and a large amount of information is made accessible to a large audience via the Internet. A potentially large group of users therefore has the possibility of principally improved orientation. Many different subjects related to women's work and lives are made public by taking up the problems of society on the net. This certainly supports and strengthens the already existing subaltern publics.

However, the information is currently poorly linked according to subject areas. Women's networks are also frequently difficult to locate on the Web. The wide range of subjects resulting from the many different approaches among the networks is thus not made accessible to all interested parties via the Internet, but instead often only to insiders. This means that the information made available on the net is only used to a sub-optimal extent, and only finds its way into the process of political opinion forming in fragmentary form.

Our study of search behavior on the Internet used log-file protocols, indicating that the most frequently used approach to searching that is keyword searches via a search engine is time-consuming and often brings limited success. Information relevant in a women's policy context has to be gathered from all the far-flung corners of the Web, at great effort. Women's policy networks are thus at risk of remaining enclaves and receiving little attention, as unconnected points in the enormous realm of cyberspace.

Interaction

In comparison to the information services—which could be improved but do at least exist—communication services with the aim of entering into lively discussion with the users on further activities are still distinctly underrepresented. The Internet is very rarely used as an instrument of interactive opinion forming. The women interviewed in the course of our study stated lack of time as the primary reason for this. They only integrate e-mail into everyday life as a matter of course. Online communities that have arisen via the net itself form an exception to this general rule, for example the Webgrrls. For these groups, interaction via the net is of decisive importance, as they do not have meeting places outside of the Web at their disposal to the same extent as networks that came about independently of the Internet.

However, in general, exploitation of the Internet's interactive potential is still in its infancy in Germany.

Political Action

Similarly, very few visible women's political activities such as petitions, online polls, or public campaigns are currently being developed on the net. Neither are there any joint, inter-organizational projects in the women's policy arena, such as public conferences or future workshops, which are jointly prepared and implemented on the Web.

To summarize, we can state that, in Germany, the Internet is primarily used by the women's networks investigated as a one-way information channel, without exploitation of the medium's interactive aspects. Their use of the networking potential of the Web is also limited. Women's organizations do not make full use of the Internet's basic potential as an information *and* communication medium.

FUTURE TRENDS

New processes must be developed to enable feminists to virtually structure and link existing information and interaction services, in order to form effective counterpublics using the technical potential of the Internet. The portals increasingly arising on the Internet are one possibility for gathering information from a variety of sources. However, portals are often financed by government or private enterprise, and thus do not necessarily provide support for subaltern counterpublics.

This aim can be better achieved using the concept of "virtual neighborhoods" (Taube & Winker, 2005). Grouping all interested women's policy networks into a virtual neighborhood means a wide range of information can be found quickly and precisely, via new types of search functions. In addition, visualizing the relationships within a virtual neighborhood illustrates content-related, regional, or other intertwined links and connections, making the closeness or distance between networks visible. Content can be structured by a problem-specific thesaurus.

Virtual neighborhoods with varying emphases can give activists an immediate overview of the varied informative and interactive projects on offer. This is particularly important for political women's networks, as their activists have fewer material and time resources, due to the gender-hierarchical division of labor and increasing everyday demands through the blurring of boundaries between work and all areas of life (Winker & Carstensen, 2004).

CONCLUSION

Women's policy activists and scholars of gender and Internet studies face the task of realizing virtual neighborhoods, and other concepts with which subaltern counterpublics can be promoted on the net, in women's political contexts in the future. Such information technology-based support can be used to develop and strengthen individual power, and to gather resources for resistance against social oppression and discrimination of identities, very much in the sense of the empowerment concept. These opportunities for e-empowerment are still only beginning to come into use, but initial successes are already visible and making their own contribution to strengthening women's political issues.

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KEY TERMS

E-Empowerment: Promoting empowerment processes via the Internet and/or computer-supported networks.

Empowerment: Gaining influence and power to control one's own life and living conditions and to participate in political processes. The aim of the concept is collective self-organization of disadvantaged groups.

Online Community: Location on the Internet where people with similar interests meet regularly, focusing on general communication and the problem-related exchange of information.

Portal: A collection of information and services from multiple sources under one Web address, provided by a central editorial body.

Subaltern Counterpublics: Subaltern counterpublics are public spaces of societal groups that are excluded from the hegemonic public and the dominant discourse (Fraser, 1997).

Virtual Neighborhood: Structure and grouping of thematically related Web presences in an independent location on the WWW, providing search options by means of a unified thesaurus and a visualization of content-related, regional, or other relationships.

Women's Policy Networks: Groups of women, regardless of their specific organizational form—women's associations, political parties, autonomous women's projects, or self-help groups.

Employment Arrangements, Need Profiles, and Gender

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INTRODUCTION

Information technology has become increasingly pervasive in the products and services of organizations. Similarly, IT has become increasingly essential in supporting work at all organizational levels. These forces have increased the demand for the work that IT professionals perform. At the same time, managerial initiatives for increased efficiencies have led to increases in outsourcing and downsizing. As a result, the IT human-resource (HR) strategies that organizations employ vary (Agarwal & Ferratt, 1999).

Different IT HR strategies are implemented through differences in HR practices, such as differences in employment guarantees, career development, and the flexibility allowed in scheduling one's work. These differences in IT HR practices result in different employment arrangements for IT professionals. According to fit theory and research (Kristof, 1996; Kristof-Brown, Zimmerman, & Johnson, 2005), the fit between what the organization supplies and what the IT professional needs influences attitudinal and behavioral outcomes, such as satisfaction, turnover, performance, and helping behavior. If an organization has a common set of IT HR practices for all IT professionals, greater fit and the organizationally desired outcomes associated with greater fit will most likely occur if all IT professionals have a common set of needs.

A question that arises is whether all IT professionals do have a common set of needs. If subgroups of IT professionals have different needs but an organization has a common set of IT HR practices for all IT professionals, that organization may not appeal to a valuable pool of potential employees. Recent analysis of the composition of the U.S. workforce shows that women are underrepresented in IT (Information Technology Association of America [ITAA], 2003, 2005a, 2005b). The percentage of women in the professional and management ranks of the IT workforce was 24.9% in 2004; the percentage in all IT workforce positions, including lower level administrative job categories, was 32.4%. In comparison, the percentage of women in the overall workforce was 46.5%. One potential explanation for this underrepresentation could be that organizations do not provide employment arrangements that address the needs of women as well as they do the needs of men and, thus, are unable to attract and retain IT professionals equally from these gender subgroups.

Research Hypothesis

Given the underrepresentation of women in IT and the potential explanation above, this research is guided by the following research question: Are women and men IT professionals homogeneous with respect to the needs they seek to satisfy in their employment arrangements? If organizations provide all their IT professionals, regardless of gender, with the same employment arrangement, and the answer to the research question is negative, that would suggest that organizations should design employment arrangements to be more inclusive of women's needs. Thus, rejecting the following null hypothesis would provide evidence that begins to build support for the explanation and potential solutions.

H_0: Women and men IT professionals have no differences in the needs they seek to satisfy in their employment arrangements.

BACKGROUND

A number of characteristics have been identified as being especially relevant for differentiating between employment arrangements (Ang & Slaughter, 2000; Kraut, Steinfield, Chan, Butler, & Hoag, 1999; Rousseau, 1995). Eleven characteristics, listed below, are included in this study. The importance of each of those characteristics is used to identify need profiles that describe different types of IT professionals based on the types presented in Enns, Ferratt, and Prasad (in press). These types are based on three broad need categories that employment arrangements may satisfy. Specifically, these need categories consist of security, achievement, and flexibility. The employment-arrangement characteristics that may satisfy a specific need category are the following:

- **Security:** (a) Job security, (b) pay, and (c) benefits
- **Achievement:** (a) Career-development opportunities, (b) the specificity of performance requirements, (c) discretion in choosing what work one does (work-choice discretion), (d) recognition, and (e) social interaction and support
- **Flexibility:** (a) Discretion in choosing when to work (schedule discretion), (b) discretion in choosing where to work (location discretion), and (c) travel discretion

Prasad, Ferratt, and Enns (2005) developed and validated a categorization procedure that places most IT professionals (i.e., approximately 80%) into one of three need profiles: high maintenance, lifestyle, and committed. The high-maintenance profile is characterized by greater needs for achievement and flexibility and a lower need for security. The lifestyle profile is characterized by greater needs for security and flexibility and a lower need for achievement. The committed profile is characterized by greater needs for security and achievement and a lower need for flexibility.

Rather than using need profiles, we could just compare women to men on each specific need. The latter analysis would assume that the mean value for a specific need within a gender group would represent all members of that group equally well, whereas the former analysis would allow for the potential that differences in a specific need exist within each gender group.

Prior research by Igbaria, Greenhaus, and Parasuraman (1991) suggests that the analysis of need profiles is a more appropriate approach for testing the research hypothesis. Although they did not measure needs associated with employment arrangements, they found significant differences in the distribution of women and men across eight career orientations (e.g., DeLong, 1982; Schein, 1987). They found that career orientations within gender groups were distributed across these eight career orientations; that is, women were not all the same in career orientation, nor were men. The percentage of women across the eight career orientations ranged from 4% (for the career orientation of entrepreneurship) to 22% (for the managerial career orientation), whereas the percentage of men ranged from 5% (entrepreneurship) to 27% (managerial). The percentages of women and men within a given career orientation were typically 20% and 80%. Of specific note were their findings for one of the career orientations, namely, lifestyle integration: a desire to develop a lifestyle that integrates family concerns, career concerns, and concerns for self-development. A greater percentage of women and a lower percentage of men than typical had this career orientation (39% vs. 20% for women; 61% vs. 80% for men). Similarly, the percentage of women with this career orientation (21%) was much higher than the percentage of men (8%). Others have noted that balancing work-family issues is a key factor contributing to the underrepresentation of women in the IT workforce (e.g., see Quesenberry, Trauth, & Morgan, in press).

Given the results of Igbaria et al. (1991), we expect that differences in needs related to employment arrangements exist among women and among men. Thus, the use of the three need profiles will allow us to test that expectation. If differences in needs related to employment arrangements exist between women and men IT professionals, we also expect that the genders would not be distributed across these need profiles in the same percentages. Given the recency of the conceptualization of these need profiles and, thus, the lack of prior empirical investigation of gender differences in these need profiles, we do not have prior expectations about what differences may exist.

METHODOLOGY

Sample

We surveyed members of a national IT professional organization. Of the organization's 3,369 members, 255 respondents voluntarily answered a Web-based survey that had a standard set of questions plus an optional set of survey questions relevant for this research. Of these respondents, 187 (73.4%) reported they were men and 68 (26.7%) women. Demographics of age, tenure with the current organization, and years worked in a full-time IT position are reported in Table 1.

Measures of Importance of Employment Characteristics

The importance of each of the 11 employment-arrangement characteristics was measured on a five-point scale (where 1 was *low importance* and 5 was *high importance*) using the same 29 items as Prasad et al. (2005). The scale value was determined by averaging the respondent's rating of how important it was that her or his preference for an item measuring that characteristic be met. An example of an item used to determine the importance of social interaction and support is "The degree of social acceptance by the people I work with." The means, standard deviations (S.D.), and reliabilities of each of the 11 importance scales are reported in Table 1.

Confirmatory factor analysis shows that the expected 11 factors emerge when analyzing the 29 items. Twenty-five items load as expected, but there are anomalies with four items. The two items measuring the importance of benefits load higher on the factor comprised of the items measuring the importance of pay. One of the items measuring the importance of career-development opportunities loads higher on the factor comprised of the items for measuring the importance of work-choice discre-

Table 1. Importance of employment-arrangement characteristics and demographics

Gender	Men			Women			Total				
Employment-Arrangement Characteristic[a]	**Mean**	**S.D.**	***N***	**Mean**	**S.D.**	***N***	**Mean**	**S.D.**	***N***	**Reliability**	
Job security	4.02	0.89	184	4.23	0.74	68	4.07	0.86	252	0.84	
Pay	3.84	0.87	187	3.99	0.84	68	3.88	0.86	255	0.88	
Benefits	3.75	1.02	186	4.10	0.94	68	3.84	1.01	254	0.85	*
Social interaction and support	3.07	0.85	187	3.34	0.75	68	3.14	0.83	255	0.83	*
Specificity of performance requirements	3.82	0.85	187	4.03	0.69	68	3.87	0.81	255	0.83	
Career-development opportunities	3.71	0.89	185	3.93	0.78	68	3.77	0.87	253	0.76	
Travel discretion	3.15	1.18	185	3.41	1.19	67	3.22	1.19	252	0.78	
Recognition	3.68	0.90	186	3.93	0.87	68	3.74	0.89	254	0.88	*
Work-choice discretion	3.52	0.90	174	3.66	0.82	64	3.56	0.88	238	0.85	
Schedule discretion	3.41	0.96	175	3.78	0.93	65	3.51	0.97	240	0.83	**
Location discretion	3.07	1.16	186	3.17	1.30	66	3.10	1.19	252	0.87	
Demographics[b]											
Age	50.66	10.28	185	46.26	8.42	68	49.48	9.99	253		**
Tenure with current organization	8.29	8.90	185	9.31	8.63	68	8.56	8.82	253		
Years worked in full-time IT position	23.24	11.22	187	17.99	10.68	68	21.84	11.30	255		***

*Notes: * p<0.05; ** p<0.01; *** p<0.001 (significance of difference by gender)*

[a] *Scale values range from 1 (*low*) to 5 (*high*)*

[b] *Scaling is in years*

tion. For all three of these items, the next highest loadings are on the appropriate factor. The fourth item, extent of the supervisor's concern, loads highly on a factor comprised of items measuring the importance of recognition. The addition of this item to the recognition scale would increase the reliability of recognition slightly from 0.876 to 0.888, while its deletion from the expected social interaction and support scale would barely lower its reliability from 0.831 to 0.830. These analyses and the reliabilities of the 11 importance scales shown in Table 1 indicate that the 11 original importance scales have adequate discriminant and convergent validity for subsequent analyses with this sample. Therefore, we use the original scales without modification.

Analysis

Since needs that IT professionals seek to satisfy are conceptualized as need profiles, testing the research hypothesis involves categorizing each IT professional into a need profile and determining whether women and men have significantly different percentages in each profile. We used the classification procedure based on Enns et al. (in press) and validated by Prasad et al. (2005) to categorize respondents into one of the three need profiles (or into an unclassified need profile if the respondent does not fit into one of the three). This procedure uses the relative importance of one item from each of the three broad need categories, as explained below. Although the procedure is not intended to be exhaustive, the validation study suggests that it will categorize about 80% of IT professionals into one of the three need profiles.

Specifically, for each respondent, we ranked the scores on all 11 importance scales (with 1 being highest and 11 lowest). We placed a respondent into (a) the high-maintenance need profile if the rank of job security was greater than or equal to 4.5, career-development opportunities was less than 9, and schedule discretion was less than 9, (b) the lifestyle need profile if the rank of job security was less than 4.5, career-development opportunities was greater than 3, and schedule discretion was less than or equal to 7, or (c) the committed need profile if the rank of job security was less than 4.5, career-development opportunities was less than 9, and schedule discretion was greater than 7.

To test the hypothesis, a chi-square test was used on the number of women and men classified into each of the three need profiles. Additional comparisons of women and men on the importance of employment-arrangement characteristics and demographics within the three need profiles and the unclassified need profile were also conducted using an analysis of variance.

RESULTS AND DISCUSSION

If we were to examine gender differences by focusing on the means of specific needs for each gender, the significant differences shown in Table 1 would lead us to conclude that women and men have different needs related to employment arrangements. Controlling for age, organizational tenure, and years of experience in IT still results in significant gender differences in the importance of benefits and schedule discretion. However, as discussed earlier, the analysis in Table 1 is based on the assumption that all women are alike and all men are alike. The more appropriate test is to examine gender differences using need profiles.

The three need profiles account for 79% of the respondents (201 of 255). Table 2 shows the distribution of women and men across these profiles. The null hypothesis that men and women have no differences in their need profiles cannot be rejected (chi-square=2.78, degrees of freedom=2, significance=0.250). Thus, these results suggest that the distribution of need profiles that the majority of women IT professionals bring to an employment arrangement is no different than the distribution of need profiles of the majority of men.

These results also show that each gender group has sizable subgroups with different need profiles,

Table 2. Gender by need profile

	Men	Women	Total
Need Profile	*N* (%)[a]	*N* (%)	*N*
High maintenance	45 (68.2)	21 (31.8)	66
Lifestyle	37 (68.5)	17 (31.5)	54
Committed	64 (79.0)	17 (21.0)	81
Total	146 (72.6)	55 (27.4)	201

Note: [a] Percent is the number of men (or women) within a need profile divided by the total number within the profile

Table 3. Importance of employment-arrangement characteristics by specified need profile

Need Profile	High Maintenance[a]		Lifestyle[b]		Committed[c]		Total[d]		
Employment-Arrangement Characteristic[e]	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	
Job security	3.56	1.05	4.38	0.54	4.45	0.58	4.14	0.86	***
Pay	3.78	0.96	3.92	0.88	3.98	0.84	3.90	0.89	
Benefits	3.68	1.15	3.94	0.95	3.94	1.01	3.86	1.04	
Social interaction and support	3.21	0.94	3.05	0.69	3.11	0.73	3.13	0.79	
Specificity of performance requirements	3.99	0.87	3.72	0.73	3.87	0.78	3.87	0.80	
Career-development opportunities	3.97	0.90	3.43	0.63	3.88	0.76	3.79	0.81	***
Travel discretion	3.26	1.36	3.37	1.09	3.07	1.09	3.21	1.19	
Recognition	3.86	0.99	3.56	0.89	3.76	0.81	3.74	0.90	
Work-choice discretion	3.76	1.05	3.48	0.70	3.47	0.80	3.57	0.87	
Schedule discretion	3.95	0.98	4.02	0.61	2.90	0.71	3.55	0.95	***
Location discretion	3.36	1.28	3.23	1.11	2.64	1.09	3.04	1.20	***
Demographics[f]									
Age	49.79	10.00	49.98	9.90	49.09	9.62	49.56	9.78	
Tenure with current organization	8.03	9.75	10.10	9.26	9.07	8.11	9.01	8.98	
Years worked in full-time IT position	20.94	11.63	22.69	10.44	21.48	10.94	21.63	11.01	

*Notes: *** p<0.001*
[a] *N=66* [d] *N=199-201*
[b] *N=52-54* [e] *Scale values range from 1 (low) to 5 (high)*
[c] *N=80-81* [f] *Scaling is in years*

consistent with an individual-differences perspective (Trauth, 2002; Trauth, Quesenberry, & Morgan, 2004). No one need profile is dominant for women or for men. Given the results in Table 2, the percentage of women with a given need profile ranges from 31 to 38% (e.g., 17/55=31% and 21/55=38%), and the percentage of men with a given profile ranges from 25 to 44% (e.g., 37/146=25% and 64/146=44%). These results indicate that there are differences among women and among men; that is, not all women IT professionals have the same needs, nor do all men.

The importance of employment-arrangement characteristics and the demographics for each of the three need profiles are shown in Table 3. Significant differences found by an analysis of variance are consistent with the definitions of the profiles. Beyond the results shown in Table 3, there are no significant gender differences on employment-arrangement characteristics within any of the need profiles. The only significant differences (p<0.05) in the demographics of women and men are in the high-maintenance need profile: Women are younger than men (45.7 vs. 51.7 years) and have worked in IT for a shorter period of time (16.1 vs. 23.2 years).

FUTURE RESEARCH

Although the respondents come from a national sample, they are not a random sample of all IT professionals. Thus, our results may not generalize to the population. Studies with other samples need to replicate our findings to increase confidence that the results generalize.

We examined one of the two key elements of fit between IT professionals and the employment arrangements provided by their employers. Specifically, we examined the needs that IT professionals bring to an employment arrangement. We did not examine the supplies provided by the employment arrangement through the IT HR practices of the employer. Future research into the effects on women and men of employment arrangements designed to satisfy the three need profiles would be appropriate.

One additional limitation suggesting a direction for future research is that about 20% of our sample of IT professionals was not classified into a need profile. This group of respondents (13 women, 40 men) has significant differences by gender. The women are younger than the men and have worked in IT for a shorter period of time (see Table 4). Further analysis of variance shows that there are

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Table 4. Importance of employment-arrangement characteristics by gender for unclassified need profile

Gender	Men[a]		Women[b]		Total[c]		
Employment-Arrangement Characteristic[d]	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	
Job security	3.67	0.85	4.19	0.48	3.80	0.80	*
Pay	3.75	0.78	4.04	0.66	3.82	0.76	
Benefits	3.63	0.90	4.31	0.66	3.79	0.89	*
Social interaction and support	3.05	1.05	3.50	0.66	3.16	0.98	
Specificity of performance requirements	3.79	0.89	4.22	0.64	3.90	0.85	
Career-development opportunities	3.54	1.13	4.12	0.74	3.68	1.07	
Travel discretion	3.03	1.18	3.96	0.95	3.25	1.19	*
Recognition	3.70	0.88	3.97	0.94	3.77	0.89	
Work-choice discretion	3.36	0.95	3.95	0.60	3.51	0.90	
Schedule discretion	3.19	1.10	3.80	0.79	3.35	1.05	
Location discretion	3.19	1.12	3.65	1.23	3.31	1.15	
Demographics[e]							
Age	49.92	11.81	45.85	5.79	48.90	10.72	
Tenure with current organization	5.61	7.34	9.94	9.01	6.67	7.92	
Years worked in full-time IT position	24.95	12.64	15.69	9.51	22.68	12.53	*

*Notes: * p<0.05*
[a] *N=28-40* [d] *Scale values range from 1 (low) to 5 (high)*
[b] *N=10-13* [e] *Scaling is in years*
[c] *N=38-53*

significant differences in the importance of job security, benefits, and travel discretion, with women rating them as more important. Controlling for age, organizational tenure, and years of experience in IT still results in a significant gender difference in the importance of travel discretion. Are there additional need profiles that would account for these apparent gender differences that remain after taking the three need profiles into account? Future research on those in this unclassified need profile could help us address this question and better understand this residual group of women and men IT professionals.

CONCLUSION

Based on investigating the need profiles of IT professionals within the context of fit theory, we conclude that a single employment arrangement is unlikely to meet the needs of the majority of women or men. Furthermore, an employment arrangement tailored to a specific need profile should fit equally well with both women and men IT professionals who have that need profile. Going further, designing an employment arrangement that is more inclusive of the needs of a specific gender does not make as much sense as designing an employment arrangement based on the specific need profiles of IT professionals. Our findings provide a compelling basis for additional empirical research to confirm the validity of these conclusions.

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KEY TERMS

Committed Need Profile: A need profile characterized by greater needs for security and achievement and a lower need for flexibility.

Employment Arrangement: What an organization supplies to an IT professional through the set of HR practices it implements.

Employment-Arrangement Characteristic: A descriptor of what an organization supplies through its IT HR practices, for example, job security, pay, benefits, career-development opportunities, the specificity of performance requirements, work-choice discretion, recognition, social interaction and support, schedule discretion, location discretion, and travel discretion.

Fit: A condition that occurs when an individual's needs are met by what is supplied in a situation.

High-Maintenance Need Profile: A need profile characterized by greater needs for achievement and flexibility and a lower need for security.

Lifestyle Need Profile: A need profile characterized by greater needs for security and flexibility and a lower need for achievement.

Need Profile: The mix of needs that characterize an individual.

Empower Gender Diversity with Agile Software Development

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INTRODUCTION

Gender issues have recently been discussed extensively with respect to the computing fields (Bair & McGrathe-Cohoon, 2005; Camp, 2002; Margolis & Fisher, 2002). One of the discussed issues is the "shrinking pipeline" phenomenon (Camp, 1997). Camp shows how, in addition to the shrinking of the pipeline upon transition from high school to graduate school, the pipeline has been shrinking also at the bachelor-degree level since 1983. She argues that since the number of women at the bachelor's level affects the number of women at levels higher in the pipeline and in the job market, this phenomenon is of great concern.

The shrinking pipeline is explained in various ways. Among other explanations, the image of the field as requiring long hours of programming is a dominant one. Here is an illustrative case. The April 3, 2003, edition of the *Pittsburgh Post-Gazette Business News* addressed the question of why more women are not involved in the tech fields.[1] This question was discussed by a panel, assembled by the Pittsburgh Technology Council a week before the article was published, which included some of the region's most successful women. Among other arguments, Robbin Steif, chief financial officer of Maya Design, said, "It might be an issue of self-selection—women might not be risk takers." Then she added, "It might also have something to do with the work/family issue, because entrepreneurs work way more than 40 hours per week."

This article focuses on software development teams using one of the agile software development methods. A high quality of working software is the primary measure of progress; however, agile software development processes, in addition, promote a sustainable pace for all the individuals (developers and users) involved in the software development process,[2] welcome requirement changes even in late stages of the development, and favor face-to-face communication. Based on our observations of agile software teams both in academia and in industry, we claim that such software development frameworks enable women to gain new and better positions in the hi-tech industry in general and in software development teams in particular. We view this article as an example of how diversity can be achieved in software teams. In our current research, we explore other dimensions by which diversity can be achieved in software teams, such as minorities and nationalities.

The perspective and data that are presented in this article are part of our research about human aspects of software engineering, specifically our comprehensive research about cognitive and organizational aspects of agile software development methods both in the industry and academia (Dubinsky & Hazzan, 2004; Dubinsky, Talby, Hazzan, & Keren, in press; Hazzan & Dubinsky, 2003a, 2003b; Tomayko & Hazzan, 2004).

BACKGROUND

The aforementioned image of the hi-tech industry in general and the software industry in particular was developed mainly during the dot-com bubble era. In those days, the media painted a picture of the dot-com world as a sleep-on-the-office-floor and sacrifice-your-family-time way of life. This image might tend to discourage women from entering the computing field and can partially explain the significant decrease in the female population of computer-science students over the past 20 years, from 35% in the 1980s to a 15 to 20% level at the beginning of the millennium (Camp, 1997; Davies & Camp, 2000).

The above picture accompanied data that indicated that the software industry suffers from many typical problems. For example, software projects fail to be delivered on time, exceed their budget, and do not comply with the requirements put forth by the customer (see, for example, Fairley & Willshire, 2003). Furthermore, according to the National Institute of Standards and Technology (NIST) news release[3] on June 28, 2002, "[s]oftware bugs, or errors, are so prevalent and so detrimental that they cost the U.S. economy an estimated $59.5 billion annually, or about 0.6 percent of the gross domestic product."

The Agile Approach and Extreme Programming

During the 1990s, the agile approach of software development started to emerge as a response to the problems of the software industry. Specifically, the agile software development approach, composed of seven methods, formalized development frameworks that aimed at overcoming these characteristic problems of software projects (Highsmith, 2002).

Extreme programming is accepted as the most commonly used agile software development method. It is based on four values expressed by 12 practices, which support and complement each other. The four extreme-programming values are communication, simplicity, feedback, and courage. The 12 practices, as originally envisioned by Kent Beck (2000), are the planning game, pair programming, refactoring, simple design, continuous integration, test-driven development, collective ownership, coding standards, short releases, metaphors, a sustainable pace, and on-site customers.[4]

The extreme-programming values and practices were selected based on the accumulative insight derived from extensive experience in the software industry, and from the recognition that quality software systems should, perhaps, be developed by adhering to very specific and detailed practices. Rather than stating principles and development phases that can be interpreted and implemented differently by different software teams, the extreme-programming practices outline a very detailed procedure for the actual development of software systems.

Since extreme programming is the most accepted agile software development method, when we assimilate it with a specific software development team, we adopt its values and practices as basic and, if necessary, adjust them in the spirit of the agile approach according to the team's needs. In this article, we refer to the adjusted extreme-programming method as the agile method.

Women's Management Style

According to Fisher (1999, p. 32), "Women's style of management is based on sharing power, on inclusion, consultation, consensus, and collaboration. Women work interactively and swap information more freely than men do. Women managers encourage their employees by listening to, supporting, and encouraging them."

In addition, recent research studies have identified several characteristics attributed to women's management style. Here are some examples (italics added by authors).

- *Women's management style is more equal and collaborative, often described as 'transformational', in contrast to the traditional 'transactional' style preferred by men who rely on power position and formal authority.* (Vinnicombe & Singh, 2002, p. 121)
- *Recent research indicates women's management style, which is centered on communication and building positive relationships, is well suited to the leadership paradigm of the 90's.*[5] (Peters, 2003)
- *The women's management style builds very much on participation by the employees and mutual trust, and they become very disappointed if the employees do not live up to that trust.* (Kjeldsen & Nielsen, 2000)

Needless to say, these attributes are compatible with any good management style; however, as the above quotes indicate, research attributes them to women.

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Data Resources

The data presented in this article are gathered from two resources. The first is comprehensive research that takes place at the computer science department of Technion—Israel Institute of Technology in a project-based operating-systems course. In this course, the agile method has been used since the summer 2002 semester by teams of 10 to 12 students, each team guided by an academic coach. Each student is a developer and, in addition, has a management role that deals with a specific aspect of the software project management. In other words, all students are involved in specific managerial aspects in addition to their role as software developers (the description of all roles is presented in Dubinsky & Hazzan, 2004). A Web-based tool is used for project management and for students' personal reflections written after almost each weekly meeting. The data gathered in this course represent 27 projects developed through the agile method by about 300 students. We would like to highlight the fact that diversity in these teams was expressed not only in terms of gender. For example, one of these teams consisted of males and females, Arabs and Jews, religious and nonreligious students, and new immigrants and native Israelis. It is felt very clearly how this mix influenced negotiation, discussion, and cooperation in the work style. As has been mentioned before, we further explore this phenomenon.

The second resource for data is long-term research (started a year and a half ago) in the Israeli Air Force software unit. In this case, we guide a software team in the assimilation of the agile method and consult during its implementation process (Dubinsky et al., 2005). The data in this case represents one project with 15 teammates involved.

MAIN THRUST OF THE ARTICLE

The agile approach reflects the notion that development environments should support communication and information sharing, in addition to heavy testing, short releases, customer satisfaction, and a sustainable work pace for all individuals involved. The main characteristics of women's management style as quoted above are collaboration and sharing, communication, and trustful and positive working relationships. In what follows, the suitability of the agile approach to the characteristics of women's management style is presented and accompanied by data gathered from the above resources. Specifically, we examine the above-mentioned characteristics of women's management style in light of the agile principles that support them. Based on this analysis, it is argued that the agile method has the potential to be very well suited to women's management style.

Communication

Communication is vital for an agile team in order to be effective and to produce quality working software. A communicative-oriented examination of the behavior of 294 students, who worked according to the agile method during eight semesters in 27 different groups, reveals that females are equally communicative. Specifically, the communicative behavior is measured using the electronic forum that the students use. Figure 1 illustrates this observation, presenting the percentages of the number of students—228 males (77.6%) and 66 females (22.4%)—and the percentages of the number of forum messages the students sent—4,702 messages by males (77.2%) and 1,391 by females (22.8%).

This observation of female students who are equally communicative reoccurs each semester. Figure 2 presents the two most not-equal semesters: In Figure 2a, the female students were less communicative, but in Figure 2b, the female students were more communicative than the male students. These two figures illustrate that even in

Figure 1. Communicative behavior

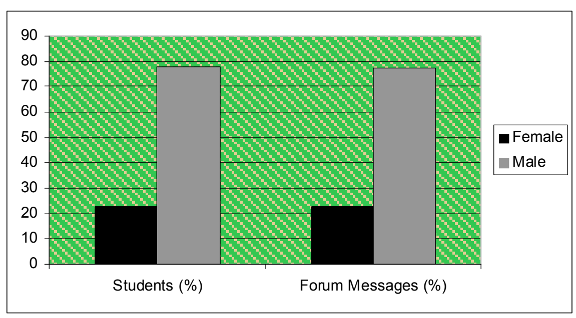
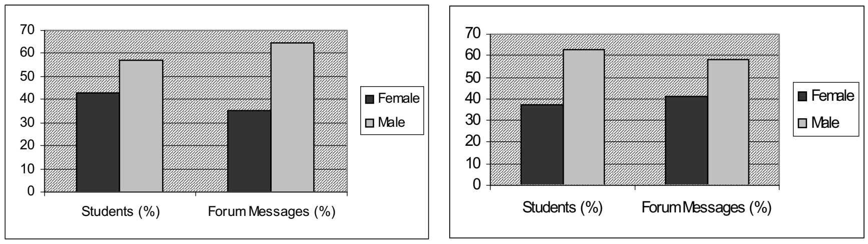


Figure 2. Communicative behavior in two specific semesters



these not-equal cases, the difference is expressed in a small percentage. Specifically, in the semester represented by Figure 2a, the percentage of female students was 42.9% and the percentage of their forum messages was 35.4%; in the semester represented by Figure 2b, the percentage of female students was 37.5% and the percentage of their forum messages was 41.5%. Due to space limitations, we are unable to present examples of messages and their analysis. However, based on a preliminary analysis of such messages, as well as based on the data presented in this section, we may conclude that female students feel comfortable with the agile principle of communication.

Collaboration and Sharing

Collaboration and sharing in agile software development environments are expressed by some of the agile principles and practices. Developing things together, specifically through pair programming, is already found as one of the practices that can expand the shrinking pipeline (Werner, Brian, McDowell, Bullock, & Fernald, 2005).

We illustrate the fitness of this aspect of the agile method to female students by data taken from one semester. In this semester, three groups of students—altogether 32 students including 20 males and 12 females—were guided by three different academic coaches and developed three different products. Specifically, we examine one answer to one of the last week's reflection questions, which asked whether the work in a large team of students contributed to the software development process, and if yes, how.

Out of 20 males, only 11 answer the question, using altogether 469 words (average 42.6, median 36). Out of 12 females, 9 answer the question, using altogether 965 words (average 107.2, median 110). We present the word-count data since it delivers a clear message: The female students found the question intriguing.

An in-depth examination reveals additional aspects. Looking for phrases that indicate collaboration, we found that 8 males out of 11 and 7 females out of 9 used collaboration phrases. Here are several examples of collaborative phrases: "it was a great challenge to coordinate all teammates ... ", "The experience…involves interpersonal relationship ...", "I think that everyone felt during the semester that he has a backup in any case of a problem." Looking for phrases that indicate sharing, 1 male out of 11 and 3 females out of 9 use phrases that indicate sharing. Interestingly, all the sharing phrases referred to situations in which other teammates shared information and ideas with the student who answered. For example, one student answered, "In this way you can learn more about other people's ideas and solutions." As we can see, female students feel comfortable with the agile principles of collaboration and sharing.

One of the solutions to the implementation of the agile method in the industry addresses the inclusion of the software quality-assurance aspect into the general software teamwork, and by doing so ends the ongoing competition between developers and quality-assurance testers. In a previous work (Dubinsky et al., 2005), we present a set of agile metrics that emerged during the first release of a product. One of the metrics, Product, describes the size of the product by counting test points. The sharing event we would like to highlight here happened after three iterations when it became clear that test writing causes a bottleneck. Consequently, it was decided that at the beginning of the fourth iteration, the main tester would teach the developers to write automatic test scenarios for the code they develop. Accordingly, during the fourth iteration, the tester taught the developers to write tests, and consequently wrote fewer tests by herself. The result was a sharp increase in product size during the fourth iteration when more and more developers started writing tests. We bring this story here since the accumulative experience with software development processes teaches that such knowledge sharing is very rare and therefore should be appreciated.

Trust and Positive Working Relationships

These two features of women's management viewpoint are grouped together since both, as is explained in what follows, convey a less competitive working environment. As mentioned previously, the agile method lays out specific practices that aim at guiding software developers during the process of developing quality software products. In our opinion, this attribute—the laying out of specific procedures—enhances trust and contributes to positive working relationships. More specifically, if specific procedures are adhered to, and if it is clear that by following such procedures no one is being taken advantage of by others since everyone is following the same procedures, the tendency toward competition is reduced and the element of trust is intensified. Further examination of this perspective is presented in Hazzan and Dubinsky (2005).

So far, one can agree that it indeed seems that the agile method suits women's management frameworks very well. But, at the same time, one can claim that since the agile method is about software development, and since this industry requires a long workday, as previously explained, women would tend not to join agile teams even though it may be compatible with their values. However, as it turns out, and as will be explained in what follows, even this barrier has been eliminated in agile software development environments.

One of the agile principles is sustainable pace. The rationale for keeping sustainable pace is that overworked programmers are unable to produce quality code. Since other agile principles, for example, developing together, ensure productivity during the 40-hour week, agile programmers can work at a sustainable pace, be productive, and produce quality code. The following data illustrate this productivity. Based on 31 projects in which developers were early adopters of extreme-programming or agile methods, Reifer (2002) indicated a 25 to 50% reduction in time to market. This evidence shows that the agile method inspires a productive and efficient working environment without long work hours. The agile method delivers the message that quality and productivity can be achieved at a sustainable pace as long as the work hours are managed efficiently.

As it turns out, it is not only the agile method that advocates the sustainable-pace concept. For example, in *Software Project Management*, Hughes and Cotterell (2002) state,

There is good evidence that productivity and the quality of output goes down when more than about 40 hours a week are worked ... Clearly, it is sometimes necessary to put in extra effort to overcome some temporary obstacle or to deal with emergency, but if overtime working becomes a way of life then there will be longer term problems. (p. 226)

Indeed, in some cases this principle is presented as a general guideline or as a recommendation. At the same time, however, in agile development environments this concept is one of the core principles of the approach, and for an agile team, working at a sustainable pace is an integral part of the development framework.

FUTURE TRENDS

Encouraging potential female software developers to join the agile community requires an explanation of the development environment that this method inspires. This can be done in various educational frameworks. Indeed, following their origins in the industrial sector, agile methods have been explored in computer-science and software-engineering education, in educator symposiums instituted in conferences on agile methods (e.g., Eckstein, 2003), and in general computer-science and software-engineering education conferences (e.g., Bergin, Caristi, Dubinsky, Hazzan, & Williams, 2004).

CONCLUSION

Many associations undertake to promote women in the hi-tech industry. In most cases, these organizations seek ways to help women adjust to the prevalent work framework that characterizes this industry in general and software projects in particular. By presenting the agile software development environment, in which women can feel comfortable without requiring any adjustment, this article offers another way by which to recruit women into the software industry, and in doing so, helps to partially expand the shrinking pipeline.

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KEY TERMS

Agile Software Development: The software development approach that values individuals and interactions over processes and tools, working software over comprehensive documentation, customer collaboration over contract negotiation, and responding to change over following a plan (http://agilemanifesto.org/). Several software development methods belong to this family; the main ones are extreme programming, the Crystal family, scrum, feature-driven development (FDD), DSDM (dynamic system development method), and adaptive software development.

Extreme Programming: Extreme programming is the most accepted agile software development method. According to the way it was originally described in Beck (2000), it is based on four values and 12 practices that together create a software development environment that encourages communication, simplicity, trust, and feedback. In the second edition of Beck's work (2005), it is rephrased in order to reflect the changes that occurred in the software industry.

Pair Programming: One of the extreme-programming practices. In pair programming, every piece of code is written by two teammates, where one acts as the driver and the other as the navigator; that is, one examines the details of a specific code and one examines the code from a more global point of view.

Software Development Method: A collection of principles and practices that inspire the development process of software products. During the relatively short history of software development, different software development methods have been suggested. Though there are differences between them, they all include the core activities of software development: requirements, design, coding, and testing.

Software Engineering: The application of engineering principles to software. It applies principles of computer science and mathematics for the development, operation, and maintenance of software. Software engineering addresses not only the technical aspects of building software systems, but also social, management, and cognitive topics.

ENDNOTES

1. http://www.post-gazette.com/pg/03093/171152.stm
2. Look at the agile manifesto at http://agilemanifesto.org/ and principles at http://agilemanifesto.org/principles.html
3. http://www.nist.gov/public_affairs/releases/n02-10.htm
4. In the second edition of his book (Beck, 2005), the value of respect is added and the practices have been slightly changed.
5. http://www.leader-values.com/Content/detail.asp?ContentDetailID=346

Empowering Homemakers to Become E-Homepreneurs

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INTRODUCTION

A number of factors explain why homemakers would want to transform themselves into home workers. Among these are the desire to rebuild confidence in one's own abilities by earning money after years of being a homemaker, the formation of a new network of mother friends who are also business partners, and the learning of skills needed for a home-based business (Ping, 2000). One of the skills that are increasingly being developed among groups engaged in business enterprises is the utilization of ICTs for work. For example, an ICT project in South India involves the setting up of telecenters that enable rural families to access ICT. The training of educated youth, especially women, in operating information shops has resulted in groups of women with small business enterprises and savings cooperatives (Balaji, Kumaran, & Rajasekarapandy, 2002). An important feature of the groups' use of ICTs for work is the strong sense of ownership that the communities develop for the telecenters, as well as the participation of women in the management and use of the telecenters. Close consultation between the project staff and users, gender sensitivity, and the use of local language in the computer programs are the important features of the project.

To specifically address the needs of disadvantaged women in Malaysia, the eHomemakers (http://www.ehomemakers.net) network started a pilot project in 2002 known as Salaam Wanita. The Salaam Wanita community consists of aspiring home workers and homepreneurs from the Klang Valley and Ipoh. Members are urban-based, low-income, and unemployed homemakers (single mothers, disabled persons, caregivers for disabled or aged dependents, and those who are chronically ill like SLE [systemic lupus erythematosus] patients who cannot work or go outside to work due to sensitivity to light and susceptibility to injuries). They are mostly homebound because of physical disabilities or home situations. Some are plagued by depression and suicidal tendencies. Consequently, they are economically constrained due to their inability to find work or business opportunities outside their homes. The Salaam Wanita project is designed to empower these women to network, and to gain ICT and microentrepreneurial skills for socioeconomic self-reliance.

JUSTIFICATION OF GENDER-GOVERNANCE FRAMEWORK

Information and Communications Technologies for Development (ICT4D) is increasingly recognized by the development community and governments as an effective means for poverty alleviation. Helping the poor and disadvantaged to become e-entrepreneurs requires organizational as well as governance and business-model innovation if the microenterprises are to be integrated into a market-based ecosystem for them ("Imagineering Rural Friendly Solution," 2005). Development goals can be attained if the information and skills transfer is based on a social-justice approach through the building of webs of exchange for the use of the marginalized (Gurumurthy, 2005).

The gender-governance framework[1] was propounded based on eHomemakers' experiences.

The key elements that form the basis of the framework are as follows.

Empowerment Must Reflect Women's Own Voice

ICT is proven to empower poor women, rural farmers, and slum dwellers in selected cases from Africa to Asia (Gerster & Zimmermann, 2004; Masud & Paim, 1999). These recent analyses show that successful ICT4D should be people centered, acknowledging the reality of people's lives with appropriate responses.

Tan (2000) cautions that the information age empowers the individual to become the epicenter of the world, affecting changes with impacts on the psyche as well as the physical body. Racing the engine of change indiscriminately will undermine the well-being of those least able to adapt and affect their ability to act rationally on their own.

Field Belenky, McVicker Clinchy, Rule Goldberger, and Mattuck Tarule (1986) propound that sanctioning women's voices in development allows each individual to be understood on her own terms, helping her to be responsible when her conception of self is rooted in a sense of connection and relatedness to others. Women's roles and maternal practices shape women's thinking about human development. The authors group women's perspectives of knowing into five categories: silence (women experience themselves as voiceless), received knowledge (women conceive of themselves as capable of receiving and producing knowledge), subjective knowledge (truth and knowledge are conceived as private matters), procedural knowledge (women learn and apply objective procedures to obtain and communicate knowledge), and constructed knowledge (women view all knowledge as contextual and experience themselves as knowledge creators). As such, women's development is about helping women to develop authentic voices, emphasizing connection, understanding, and acceptance of women's realities.

An increase in disadvantaged women's ability to go from silence to the other four perspectives of knowing will enable them to enter and sustain viable e-entrepreneurship. Such transformation must be carried out in a lifelong learning manner to promote the knowledge gained.

The Need for Women's Space

Inclusive women's movements and organizations should be for all women who are part of them. However, a mechanism is needed for integration and meaningful participation (Alpizar & Wilson, 2005). The centrality of indigenous gender knowledge production, and the communication and sharing of information among women stakeholders are essential for gender transformation with the use of ICTs (Radloff, 2001).

In addition, as disadvantages of ICT4D sometimes outweigh the benefits, the issue of gender exclusivity gives rise to the need for safe and secure electronic spaces for women. Such spaces will lead to women-led and women-defined development models (Wood, 2000).

Control and Ownership

As affirmed by Barch and Leon (2000), redressing unequal power relationships needs different empowerment levels: conscientisation (the disempowered become convinced of the need for actions), recognition as legitimate interlocutors (who determines what issues should be the bases of actions, and who get to be the players), and the building of power to negotiate issues of concern. If these empowerment levels are to be applied to disadvantaged women within the context of e-entrepreneurship development, it means that having the know-how to use ICT creatively and strategically (find, manage, produce, disseminate, decide, and intervene proactively at the individual level) is more important than access to ICT after conscientisation occurs. An ICT-development framework, for disadvantaged women and by disadvantaged women, instills leadership growth and sustainability momentum because the control and ownership belong to women.

Such a framework can also transform the benefactor-beneficiary relationship into a principal-client one with ICT as the catalyst.

Governance as Accountability

If the poor and marginalized are to gain basic assistance, they need to gain ownership of both the process and the outcomes (Rakodi, 2002). For development organizations to achieve true human security, they need to redress gender inequity and be accountable to women's rights (Rao, 2003). A motivated group under a development framework with strong governance principles (for self and others) brings positive changes to the group members.

Indicators and Barriers for Women's Informatization

To evaluate the level of women's informatization, the development of relevant indicators, mainly for monitoring and evaluation, can also measure the informatization rate and characteristics. They act as basic resources for change. Such indicators have not been defined in the Asia-Pacific region (Kio, Yong, So, & Hyun, 2001).

Strategic gender interest requires women to develop, create, and implement content and services that best answer their needs and interests (Jensen, 2005). Unfortunately, women, especially those in the south, face many negative experiences in the adoption of ICTs (Banks, 2000). Surveys by two women's electronic networks, APC and WINAP, revealed that women's organizations and information activists faced limitations in using ICTs. Emphasizing access to solve digital-divide problems does not address power imbalance and marginalization (Scott, Singh, & Wanasundera, 2001).

ICT is neither gender neutral nor gender blind. It discriminates against women, especially the disadvantaged, who stay at home. The way ICT operates does not support the social-economic development of disadvantaged women fully because of the barriers faced by them. ICT4D efforts for gender empowerment should make the overcoming of barriers a priority action goal within the gender-governance context.

In conclusion, a gender-governance framework with the above five elements enables women to overcome disadvantaged situations to network, and gain strength and knowledge as interlocutors. It makes women responsible for their actions and eventually influences others to be responsible for their conduct to the women.

GENDER-GOVERNANCE FRAMEWORK

Gender governance is both a goal and a process, which seeks to create a platform on which women take ownership of the management of networks and information sharing. eHomemakers attempts to promote demand-driven gender governance through information sharing, networking, and activities that enable and empower women to work from home. By combining the essence of working from home, the vigour to empower women, ICT opportunities, and the leveraging of experiences and knowledge shared within the community, disadvantaged women can achieve economic self-reliance and gender empowerment.

The 5A Process of Change outlines how women can take part in the creation of governance structures and mechanisms for their specific needs and interests. The processes are as follows:

- Awareness of the problem
- Acceptance of the need for change
- Action to be taken
- Assimilation maintaining the change
- Assessment of progress

A disadvantaged woman needs to break through barriers in order to acquire opportunities that lie ahead. Each stage of the change reflects different levels of economic empowerment. The process of empowerment is therefore a sequence of women's actions by which a gender issue, economic empowerment, can be tackled.

The first three stages require women home workers to realize and accept that they can change their situation by undertaking certain actions toward change. For e-entrepreneurship building, the assimilation stage is the beginning of the process of change, when a woman is able to use ICT to do business by networking and managing information resources on her own to ensure business viability. When she reaches the assessment stage, she completes the process of change to reach gender governance as she is able to evaluate her own efforts to overcome the barriers and take action to overcome them without heavy costs (monetary and nonmonetary) to herself. She is then able to grow her business with ICT usage and becomes an active member in business and cyber support networks. Her feedback, input, and responsive actions to the networks' needs form part of the governance of the information networks she belongs to. Because the networks' members own, control, and manage the information resources, they are able to spur corporate governance and e-governance.

RESEARCH

A 1-year research project to identify the barriers these women faced in the entry of entrepreneurship and e-entrepreneurship was conducted in 2003 and 2004 under the Pan Asia 2003 Networking Small Grant. The gender-governance framework was further refined for advocacy. One hundred and seventy-five women Salaam Wanita members participated in computer training, motivational talks, networking meetings, two questionnaire surveys, and focus-group discussions. The findings from the surveys and discussions were analyzed, and a list of major barriers to ICT and entrepreneurship were identified. Based on these, a list of indicators on women's empowerment progress was developed. The gender-governance framework was also tested during the research period.

FINDINGS

Some Salaam Wanita members within the study group have successfully overcome their disadvantages by taking control of their destinies. The effectiveness of the 5A Process of Change as a framework for assisting homemakers is evident among the successful home workers. They became aware of their problems and accepted the need to change. One of the major actions they have taken to control their disadvantaged situation is to learn new skills such as basket weaving, typing, translation, and computer and hand-phone skills. Through the project, they learn to network, to use the knowledge to market their products and services, and to be more proactive in turning their lives around.

The major barriers identified are the presented in the following sections.

General

Attitude

The single major barrier preventing Salaam Wanita members from taking up access to knowledge is the low-key attitude that takes the form of low self-confidence, high risk aversion, and passivity. They are afraid of venturing out on their own and are quick to quit when faced with obstacles.

Finances

Financial constraint is an obstacle in the acquisition of ICT equipment, maintenance, and operation even when the home-business options identified require little or no capital at all. It is also a problem if the time for home chores is adversely affected, resulting in additional costs to the disadvantaged women. They single out the cost of acquiring equipment as the main obstacle to the setting up of income-generating workstations at home.

Circumstances

Those who are chronically ill, disabled, or taking care of disabled or elderly dependents are unable to effectively enter the action stage of the process of change. This barrier is also related to their gender roles and work burden at home. Homebound women with disadvantaged dependants have less family and social support, resulting in heavier workloads at home and less time for any self-improvement activities.

Barriers to Using ICT

- **Intrinsic Nature of ICT Hardware and Software:** ICTs are not user friendly for the disabled and SLE patients. Reading text, looking at a glaring screen, and having to sit and use the hands prevent effective usage.
- **Ignorance and Fear:** The majority of women lack self-confidence and are often unable to learn basic skills even after several training sessions.
- The lack of immediate financial returns prevents them from regularly attending training sessions.

Barriers to Entrepreneurship

- Finances
- Lack of knowledge of basic business principles and the use of ICT as business tools
- Insufficient time for uninterrupted work
- Minimum family support to enable them to venture out of the house
- Discrimination by companies
- Transportation problems

- Lack self-knowledge
- Risk aversion and self-confidence
- Lack of networking
- Time
- Location

The indicators for tracking the progress of disadvantaged women in similar conditions were identified. As indicators of access, opportunity, and participation, they are related to the personal abilities of women in knowledge and skill enhancement, self-confidence building, and dealing with the external environment.[2] Another indicator area is related to the external environment (i.e., the organizational, environmental, technical, and governmental). The indicators measure a continuous process of change that is essential when establishing a network of thriving e-homepreneurs. Each of the indicators determines how and why changes in women's lives can happen within the gender-governance context. The indicators developed identify problem areas and give rise to recommended measures to resolve the barriers identified.

The indicators are divided into the following categories: the general (family and social networks, personal attributes and issues, home circumstances), the external, and technology.

CONCLUSION

Recommendations that resulted from the study are as follows.

- Change of attitude through viable role models
- Leadership cultivation for the formation of work clusters
- Innovative learning and training to address special learning needs
- Increased awareness through media
- Creation of specific policies for home working, gender mainstreaming into the national development, and relevant and specific assistance programs
- Research and development activities on innovative ICT tools and integrated platforms, content delivery, and access

Disadvantaged women are in a helpless and powerless position. They are especially vulnerable to the fast-changing pace of ICT revolution whereby technologies become obsolete within a short time span, and rules and governance are evolving constantly. Yet, ICTs are also opening immense possibilities to women. While the introduction of ICTs may make women work at lower skill levels, others who learned a combination of ICT and entrepreneurial skills experienced skills upgrading and new work opportunities (Saloma, 2001).

It is therefore imperative to ensure that women have access to ICTs at a level on which they can use them for work in accordance to their realities. In the case of the urban disadvantaged women, ICT4D for poverty alleviation should thus include gender governance: the ability by women to own and control the management of information networks for themselves and by themselves as the basis for gender mainstreaming. The framework should be used as an evaluation tool for projects involving e-entrepreneurship, e-networking, teletrading, and ICT-based self-help. The indicators developed from this study measure a continuous process of change that is essential when establishing a network of thriving e-homepreneurs. Each indicator determines how and why it leads to changes in women's lives within the gender-governance context.

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KEY TERMS

Digital Divide: The term digital divide describes the fact that the world can be divided into people who do and people who do not have access to—and the capability to use—modern information technology, such as the telephone, television, or the Internet. The digital divide exists between those in cities and those in rural areas. The digital divide also exists between the educated and the uneducated, between economic classes, and, globally, between the more and less industrially developed nations.

E-Homepreneur: An entrepreneur who creates and manages a home-based business using ICTs.

Gender Mainstreaming: Mainstreaming a gender perspective is the process of assessing the implications for women and men of any planned action, including legislation, policies, or programs, in any area and at all levels. It is a strategy for making the concerns and experiences of women as well as of men an integral part of the design, implementation, monitoring, and evaluation of policies and programs in all political, economic, and societal spheres so that women and men benefit equally, and inequality is not perpetuated. The ultimate goal of mainstreaming is to achieve gender equality.

Governance: Issues related to the involvement of stakeholders—scientists, the industry, consumers, and public authorities—in the process of innovation-policy design, implementation, and evaluation.

Homepreneur: An entrepreneur who creates and manages a home-based business.

Home Workers: People who either telework or run home-based businesses.

ICT (Information and Communications Technology or Technologies): An umbrella term that includes any communication device or application, encompassing radio, television, cellular phones, computer and network hardware and software, satellite systems, and so on, as well as the various services and applications associated with them, such as videoconferencing and distance learning.

ICT4D (Information and Communications Technologies for Development): An initiative aimed at bridging the digital divide (the disparity between geographic locations or demographic groups who have and do not have access to or the capability to use technology) and aiding economic development by ensuring equitable access to up-to-date communications technologies.

SLE (Systemic Lupus Erythematosus): Commonly called lupus, it is a chronic autoimmune disorder affecting virtually any organ of the body. With lupus, the body's immune system, which normally functions to protect against foreign invaders, becomes hyperactive, forming antibodies that attack normal tissues and organs, including the skin, joints, kidneys, brain, heart, lungs, and blood.

ENDNOTES

1 The proposed gender-governance framework was developed by Chong Sheau Ching, manager of eHomemakers, in 2002.

2 The emphasis on welfare, awareness, access, opportunity, and participation is also at the heart of the gender-equality and women-empowerment framework (United Nations Children's Fund, 1994). The gender-governance framework's contribution to this kind of analysis lies in its attempt to introduce the use of ICTs for the attainment of gender equality and women's empowerment.

Engendering Universal Access to ICT in Rural Areas

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INTRODUCTION

The concept of community access to information and communication technologies (ICT) has gained widespread attention as a strategically vital response to the perpetual lack of affordable access to ICT and ICT services in the developing world, particularly in rural and peri-urban[1] poor areas. Community access is not in itself a new idea; however, it provides an encouraging policy approach to overcoming the wide disparities of access and, as such, to provide opportunities for developing societies and historically disadvantaged regions and populations to participate in the newly emerging social and economic orders. This article focuses on community access centers as essential to facilitate access to ICT for women in rural areas in the developing world.

TOWARDS UNIVERSAL ACCESS: THE NEW POLICY DIRECTION

Universal service is traditionally defined as access to a telephone in every household. While the percentage of households with telephone service is high in developed countries, it is quite low in most developing countries. According to the International Telecommunications Union (ITU), by 2003, 96% of households in high income or developed countries have a telephone. In contrast, only about 13% and 37% of the households in Africa and Asia, respectively, had a telephone. In terms of teledensity, high-income developed countries had about 71 lines per 100 inhabitants, while countries in Africa and Asia had on average 5.5 and 14 lines per 100 inhabitants by 2003 (ITU, 2003). When we look at the urban-rural disparity in developing countries, the figures are even more depressing. While about 60% of the population in developing countries live in rural areas, more than 80% of the telephone lines are in urban areas. Women are a large percentage of rural populations and women-headed households are increasing everywhere.

The magnitude of this problem—*the access gap* (or the digital divide)—has led to a recent rethinking of universal service policies for developing countries. Indeed, a telephone line per household may not be economically or technically feasible for many developing countries. Therefore, the wider concept of *universal access* to ICT has become the focus. This new approach to universal service provides a shift from the concept of a "telephone per household" to wider "community access" to telecommunications and related services. In fact, it not only broadens the definition but also changes the concept of access to telecommunications to mean access to ICTs. ICTs include, in addition to traditional telephony, faxing services, computer services, photocopying, electronic mail, Internet access and access to an array of local, regional and national information previously available only to a few.

Community access centers, or telecenters, have recently become a development option to address the lack of access to ICT in many countries of the world, particularly developing countries. They offer an alternative model for access in areas traditionally lacking telecommunications infrastructure, such as rural and peri-urban areas, and provide an array of ICT services, training and resources needed for communities' development.

Despite their potential, community access centers will most likely function and be successful within a specific policy environment, one that develops and promotes the necessary support systems and appropriate policies to allow for sustainable centers (e.g., ensure gender equity in the implementation process, promote pricing policy that favors discounts for community access centers' services, financial incentives that promote investment where it is most needed, among others). If policy makers want to contribute to universal access in their countries, experience around the world shows that they should focus their attention on the demands of their rural and peri-urban population, and community access centers provide an option worth investing in.

COMMUNITY ACCESS CENTERS: A GENDER PERSPECTIVE

Despite greater awareness and evidence on the impact of gender analysis in development work, women and girls continue to benefit marginally from developments in ICT and access to services in many countries and environments. Women's ability to benefit from the access to and use of ICT as tools for social and economic empowerment is constrained in a number of ways, including social and cultural factors, income levels, education levels and illiteracy, and lack of knowledge on the potential of ICT, among others. According to a recent report, the following are some key socio-cultural factors that constrain women's use of ICT, particularly in rural areas (Gurumurthy, 2004, p. 24):

- *Cultural attitudes discriminate against women's access to technology and technology education.*
- *Women are less likely to own communication assets—radio, mobile phone.*
- *Women in poor households do not have the income to use public facilities.*
- *Information centers may be located in places that women are not comfortable visiting.*
- *Women's multiple roles and heavy domestic responsibilities limit their leisure time. Centers may not be open when it is convenient for women to visit them.*
- *It is more problematic for women to use facilities in the evenings and return home in the dark.*

Gender analysis and considerations are often neglected or integrated only too late (Hafkin & Jorge, 2002). Even in community access center projects, which tend to be community focused and supposedly more aware of community needs, gender has not become an integral part of the planning equation. A few centers around the world have committed themselves to targeting women and women's needs; however, they have encountered tremendous difficulties. Most of these problems

Figure 1.

Self Employed Women's Association (SEWA): Promoting ICT Use Among Women

SEWA, India, is a member-based organization of poor, informal-sector women workers. Two-thirds of its members live in rural areas and are home-based workers, vendors, manual laborers, service providers and producers. SEWA's ICT unit has been exploring the use of ICT as a tool to increase the efficiency of rural micro-level enterprise activities to secure poor women's livelihood. SEWA has successfully taken an integrated and holistic approach to the use of ICT for rural development, such as providing its members with access to information; training them with communication tools and customized software; technical training on repairing their tools; generating job opportunities; and also providing child care and health care. Some of their current activities on ICT include:

- Imparting basic computer training for semiliterate women before they are introduced to communication tools, such as Internet and customized software for their micro-enterprises
- Providing technical training, such as maintenance and repairs of their tools
- Providing loans for mobile phones for informal sector workers; that is, vegetable vendors
- Proving health advice and nutritional information by linking with hospitals via video conferencing for villagers who are laborers and service providers who do hard physical work to earn a living and survive; that is, construction workers and salt workers
- Exploring various partnerships with different medical institutes and organizations for providing better access to health care services for its members; that is, telemedicine.

Source: Dhara Patel, coordinator, ICT, Self Employed Women's Association (SEWA), India, presentation at the World Bank, July 2003, cited in Financing ICTD: A review of trends and an analysis of gaps and promising practices, the report of the Task Force on Financial Mechanisms for ICT for Development, UNDP (2004).

Figure 2.

Community Telecenters – Beyond Access

Beyond generating new jobs for women, ICT are being used in projects that address other gender and development issues related to poverty reduction. For instance, projects in South Asia that focused specifically on income-generating activities and direct employment benefits for women created a space for information exchange, provided support networks and developed a range of interrelated social, technical and economic skills. Participants acquired the confidence for autonomous activity that made a significant contribution to their empowerment. Although ICT have not yet had significant impact on creating employment and generating income for very poor and marginalized women, there is potential through increasing their engagement with ICT to expand social networks and introduce new modes of learning that can play a key role in overcoming poverty in the future.

Nabanna is a project located in Baduria, in West Bengal, India. Women in Baduria did not have structured local communication networks that promoted access to information or provided spaces for sharing information and knowledge. Many of the women involved in the project report that they have gained more respect in their local communities as a result of the ICT skills learned at the Baduria ICT center—both learning to use a computer and accessing and distributing information to local people. This has resulted in greater respect at both family and community levels. Younger women feel they are able to approach the job market with greater confidence. There has also been an emergence of solidarity—since women learn to use computers together at the ICT center, they also often discuss their problems, creating a sense of unity among them and also bringing forth inherent and latent leadership qualities.

Source: Ramilo, Jorge, & Hermawati (2005); http://www.bellanet.org/leap/docs/136121e.pdf?OutsideInServer=no

result from lack of gender analysis and training to correctly address the specific needs and demands of women and girls. A number of women organizations have had greater success in introducing ICT to rural women (see the box). It is, however, crucial to invest in gender analysis and training to ensure that access centers consider gender issues from the planning stages through implementation and evaluation.

By integrating gender analysis in their planning process, community access projects will be able to more clearly identify the disparate needs of women and men in the communities they serve. Specifically, they may consider all of the following requirements in the planning states:

- Conduct active outreach (i.e., to promote the center and ensure that it works with women's organizations active in providing services to the community)
- Ensure financial accessibility (i.e., price for access and for services)
- Ensure physical accessibility (i.e., strategic location)
- Provide training (e.g., training for women by women on various ICT-related areas)
- Ensure relevance (e.g., provide content relevant to local women's needs in their own language)
- Build confidence (e.g., promoting use by women and facilitating income-generating activities)
- Enable participation (e.g., creating welcoming environments).

Community access centers that take these factors into account are more likely to attract women users, increase demand for their services and, consequently, become sustainable enterprises. Community access centers can further benefit rural women and girls and contribute to their lives in numerous ways (see the box), including:

- Providing access to an array of ICT and related services, such telephony, access to computers and computer training courses, access to the Internet and e-commerce opportunities, access to radio programming and other audio-visual media, access to government information, employment information and opportunities, tele-education programs, health care information and, in some cases, actual treatment via tele-medicine programs
- Providing a business opportunity, in that many women or women's community organizations can become owners or managers of different types of community telecenters

- Creating jobs for women in telecenters, where women can participate in community development activities and better incorporate women's specific programs within telecenter plans
- Providing community-specific or community-focused programs, such as literacy projects, relevant content development opportunities, ICT training, farming or other economic activity information, trading information, government data, health information and projects, among others
- Providing women-specific or gender-aware programs, such as literacy projects, ICT training (for personal, community and business use), knowledge sharing programs, e-commerce initiatives and women's health information projects, among others
- Providing an incentive for businesses to locate in rural areas in the proximity of telecenters and to employ telecenter-trained workers
- Providing the skills necessary for members of rural communities to begin to develop their own business applications, such as developing community-based Internet service providers (ISPs), as has been the case in the United States.

UNDERSTANDING THE CHALLENGE AHEAD

Considering the possibilities, it is clear that community access projects must integrate gender in all stages of project development and implementation. Experiences from telecenters around the world show that, among other things:

- Women use the telephone (and increasingly, mobile phones) more then computers
- In general, women feel more intimidated by computers (particularly older women), but are interested in learning
- Lack of relevant information in local language is a disincentive for use of ICT services
- ICT provide opportunities beyond access, including networking and knowledge sharing among women
- Due to high illiteracy rates, many women relate best with radio, video, audio and other multimedia sources of information
- Women are more comfortable with women trainers and, in some cases, more comfortable in women-only training environments
- Most women would like to use resources provided by community access centers.

Clearly, women are interested in using ICTs; however, it is essential that community access centers being implemented throughout rural areas address women's concerns and provide an adequate environment for women's participation in and strategic use of ICT.

NOTE

Adapted from an earlier paper by the author: Jorge, S. N. (2002). "Telecenters for Universal Access: Engendered Policy Options," Women in Action, No.2, ISIS International-Manila.

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KEY TERMS

Community Access Centers or Telecenter: Generally refers to a community-owned and -operated initiative with the goal of providing affordable access to ICT and ICT-related services relevant to the specific community it serves (including locally relevant content in local language, a focus on the preferred technology, etc.).

Gender: Gender refers to culturally and socially constructed roles and behaviors of women and men, and identifies the social relations between women and men. It is distinct from the biological difference between women and men.

Gender Analysis: It involves the systematic research and analysis of information based on gender differences and relations, in order to address inequalities and work towards gender equality.

Information and Communication Technologies (ICT): New ICT generally refer to telecommunications technologies (i.e., telephone, fixed and mobile, fax, radio, TV, satellite), computer technology (i.e., to process data) and networking technologies (i.e., the Internet, voice-over internet platforms, etc.).

Universal Access to ICT: The ability of any individual, regardless of location (geographical location), income, gender, race, age, language and so forth to access ICT at a shared community access point at a reasonable distance (which can be defined by walking distance, number of meters, kilometers or miles) from his or her household. The concept of universal access also encompasses the notion of affordable access (i.e., a price that community members can pay).

ENDNOTE

1 Peri-urban areas are those areas in the periphery of major cities and where poor populations tend to settle when they migrate closer to urban centers. Peri-urban areas often include large shanty-towns or illegal settlements with little or no infrastructure and high rates of poverty.

E

Enhancing Inclusion in Computer Science Education

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INTRODUCTION AND BACKGROUND[1]

We describe an intervention that uses computer science (CS) faculty and students to create an inclusive learning environment. Our intervention model assumes that persistence and retention are the result of a match between student motivation and abilities and the university's social and academic characteristics. This match in turn influences the effective integration of students with the university and, as a result, their persistence and retention (Cabrera, Castaneda, Nora, & Hengstler, 1992; Tinto, 1993). We are currently implementing and evaluating this intervention at Old Dominion University, a research intensive urban university with a culturally diverse student body, and Norfolk State University, an urban and historically black university (HBCU) that primarily emphasizes teaching.

A MODEL FOR CREATING INCLUSIVE LEARNING ENVIRONMENTS

Organizational Support for Faculty and Students

This portion of our model depicts external resources available to support change in faculty and students (see Figure 1). Support for faculty includes peers, teaching assistants, and external consultants who provide assistance in areas targeted for change, for example, pair programming practices. Support for students includes academic resources such as tutoring, advising, and mentoring. Professional organizations, such as the Association for Women in Computing, may provide support to both faculty and students.

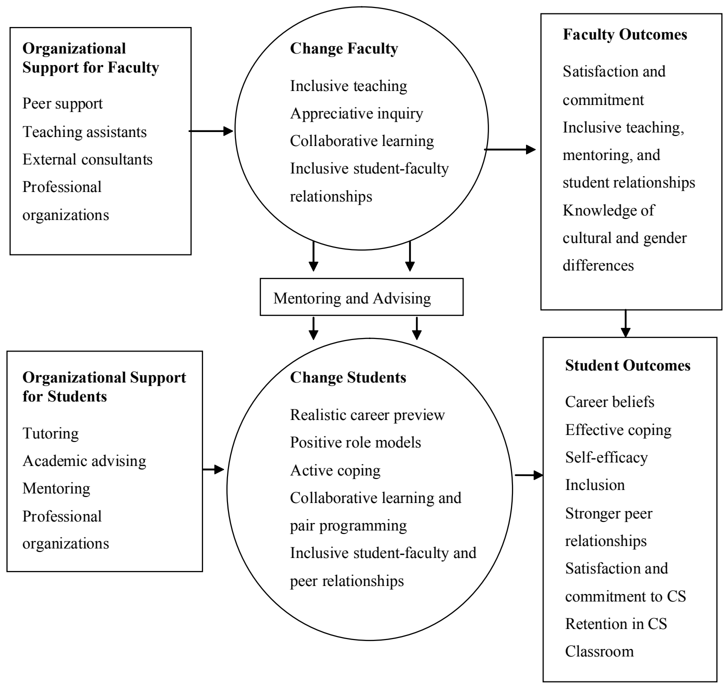
Changing Faculty

We focus on faculty because they influence student outcomes. The intervention concentrates on faculty who teach introductory programming classes because these classes represent the first and largest barrier to success in CS. We build on existing talents and strengths of faculty by emphasizing four skill areas: (1) inclusive teaching practices, (2) appreciative inquiry, (3) collaborative learning, and (4) inclusive student-faculty relationships.

Inclusive Teaching

Teaching style strongly influences retention in science, mathematics, and engineering (Seymour & Hewitt, 1997). Men and women and members of different ethnic groups experience IT work environ-

Figure 1. Intervention model for creating inclusive learning environments



ments and learning environments differently (Major, Davis, Sanchez-Hucles, & Mann, 2003; Steele, 1997; Steele & Aronson, 1995). Inclusive teaching encourages acceptance of diverse styles of learning and avoids actions based on stereotypes concerning group membership.

Appreciative Inquiry

Mentoring and tutoring typically focus on deficits and remediation. Appreciative inquiry, in contrast, emphasizes optimism, positive expectations, and challenge (Srivastva & Cooperrider, 1990). People tend to act in ways to fulfill expectations of powerful others, such as professors. Moreover, use of positive expectations energizes and directs behavior in a manner to fulfill expectations. Positive expectations may be especially powerful for those for whom low expectations are held (McNatt, 2000) or for those for whom gender or racial stereotypes influence expectations (Jussim & Eccles, 1992).

Collaborative Learning

Faculty members experience positive outcomes when they learn and share their experiences together. Collaboration may lead faculty to learn more deeply, encourage and support one another, explore new methods of teaching, increase colleagueship, discover and appreciate student differences, and develop a shared vision for teaching inclusiveness (Cox, 2002). Faculty who share learning experiences report increased interest in the teaching process, effectiveness as a teacher, and awareness and understanding of how differences may influence and enhance teaching and learning (Cox, 2002).

Inclusive Student-Faculty Relationships

The quality of exchange in relationships influences important outcomes. Inclusive student-faculty relationships enhance mentoring and advising and increase the retention of women and minority IT students (Cohoon, 2001, 2002; Gürer & Camp, 2002). Mentoring has more positive effects when it is not remedial in nature. Inclusive mentoring may be critically important because *not actively encouraging* women and minorities may have the same effect as *actively discouraging* them (Leggon, 2003).

Mentoring and Advising

Mentoring and advising link together faculty change and student change. Mentoring represents an attempt to provide information required for successful socialization and social support needed for effective stress management. Women and minorities may experience greater barriers to mentoring due to restricted access to mentors, unwillingness of mentors to mentor them, or disapproval by others of mentoring activities. Some women may also worry that a request for mentorship may be perceived to be a sexual advance (Ragins & Cotton, 1991). Women and minority students may have more difficulty establishing mentoring relationships because mentors often choose protégés with whom they can identify; this choice is often influenced by gender, race, and social class. Because women and minorities are under represented in CS, they may face greater challenges in seeking mentorship, particularly from mentors of the same gender or ethnicity (Wright & Wright, 1987). Fortunately, mixed-ethnic and mixed-gender mentorships can be as beneficial as same-ethnic and same-gender mentorships (Atkinson, Neville, & Casas, 1991).

It is important that mentoring and advising be inclusive and appreciative. Well-meaning support such as mentoring may elicit "stereotype threats" and lead to unintended negative consequences (Steele, 1997). Stereotype threat can be particularly insidious when combined with mentoring that emphasizes deficits and remediation. This may explain, in part, the positive relationship between mentoring and attrition in CS students reported by some researchers (Cohoon, Cohoon, & Turner, 2003).

Changing Students

Freshman and sophomore students in CS provide the second focus for change. Emphasis is placed on student attitudes, beliefs, and behaviors that are likely to improve socialization into the learning environment that exists in CS education and in the IT workplace. We have implemented a class required of new CS majors that has five components: (1) realistic career preview, (2) positive role models, (3) active coping, (4) collaborative learning and pair programming, and (5) developing inclusive relationships.

Realistic Career Preview

Our conception of a realistic career preview (RCP) is based on a practice developed in industry called the realistic job preview (RJP). The RJP provides potential new hires realistic—that is, both favorable and unfavorable—information that describes their likely work experience in the hiring organization. This method contrasts with traditional approaches to hiring and socialization that emphasize only favorable information. The logic of the RJP is that accurate information improves the fit between individual and organizational expectations and hence reduces later disappointment and dissatisfaction. Job candidates who receive RJPs have higher performance, job satisfaction, and organization commitment, and are less likely to quit (Philips, 1998; Premack & Wanous, 1985). RJP recipients are also more committed to training and profit more from it (Hicks & Klimoski, 1987). We expect to get the same results from the RCP.

The RCP presents to students a realistic portrayal of computer science education and careers. We use research findings to debunk common myths about working in IT, for example, we show that women in IT are frequently happy with their workplace and career in IT. We also "inoculate" students with previews of potentially difficult relationships and situations to prepare them for future challenges.

Positive Role Models

We use diverse IT professionals to serve as role models to show students the variety of career opportunities available to them with a degree in CS. Female students have less clearly defined career goals than their male counterparts when they begin studying science; they are disproportionately likely to abandon their plans to major in science after their first undergraduate year as a result (Seymour, 1999). Efforts to improve socialization during the first year of study, therefore, may have pivotal importance for improving retention among women. Margolis and Fisher (2002) recommend that early in their careers female students learn the context for technology and that they learn to understand why they are being asked to do what they do. This includes being presented with role models and career information that will help them to believe that they can be successful IT professionals.

Active Coping

Ethnic and gender minority status may interfere with the socialization process by reducing access to information and mentors and by increasing anxiety and stress (Jackson, Stone, & Alvarez, 1992). The extent to which newcomers to CS have a cultural or gender background that differs from most others in their department may reduce the rate of socialization and increase the likelihood of failure and quitting (Bauer, Morrison, & Callster, 1998). Women and minority students in CS report greater stress than other students (Davis, Gregerman, & Hathaway, 2003). The manner in which students deal with stress influences their level of social integration, institutional commitment, and intention to remain in university (Bray, Braxton, & Sullivan, 1999). We teach practices to cope with stress and anxiety that result from outsider status in order to strengthen academic and social integration. Enhanced academic and social integration increase commitment to academic goals and the academic institution and, as a result, enhance persistence and retention (Cabrera et al., 1992).

Active coping is the process of taking steps to remove or circumvent stressors or to reduce their impact (Carver, Scheier, & Weintraub, 1989). Active coping is positively associated with optimism, control, self-esteem, and hardiness, and negatively associated with anxiety (Carver et al., 1989). Moreover, when students experience stressful events, active coping is more likely to lead to efforts to: reduce stress, suppress competing activities, seek instrumental and emotional social support, and reduce maladaptive behaviors such as denial and behavioral and mental disengagement (Carver et al., 1989). Active coping also leads to increased information seeking, relationship building, positive cognitive framing of events, more successful socialization results and, as a result, increased satisfaction and intention to remain in the organization (Ashford & Black, 1996; Major & Kozlowski, 1997; Major, Kozlowski, Chao, & Gardner, 1995).

Collaborative Learning and Pair Programming

Pair programming provides an important means of collaborative learning for CS students (Williams & Kessler, 2003). Pair programming directs one partner to act as the "driver" who is responsible for writing code, while the "non-driver" partner is directed to continuously observe the work of the driver, watch for errors, and recommend alternatives. Programmers who cooperate with one another in this way work faster, detect more errors, create higher quality programs, express more satisfaction with their work, and report more confidence in their programs than do programmers working in isolation (Williams, 1999; Williams & Kessler, 2000a, 2000b; Williams & Kessler, 2001). Students who program together in pairs achieve higher grades and may be more likely to remain in CS (McDowell, Werner, Bullock, & Fernald, 2002; Williams, Wiebe, Yang, Ferzli, & Miller, 2002).

Inclusive Student: Faculty and Peer Relationships

As IT has permeated all organizational functions, employers of IT workers have encouraged development and use of "soft skills," such as communication, interpersonal relationships, teamwork, and working with diverse coworkers. Interviews with senior managers in IT reveal that such soft skills are better predictors of on-the-job success among IT workers than technical experience or skills (U.S. Department of Commerce, 2003), yet soft skills are not taught in conventional undergraduate CS programs (Bevan, Werner, & McDowell, 2002). Moreover, the global nature of IT requires the ability to work successfully with people from different cultural backgrounds; such knowledge should be part of the CS and IT curriculum (Little et al., 2000). Working effectively in teams and developing inclusive relationships with others from different cultures requires special knowledge and skills (Davis & Bryant, 2003). We highlight for CS students the importance of cultural differences and the need to consider these when developing relationships with faculty, graduate teaching assistants, and other students.

CONCLUSION AND FUTURE DIRECTIONS

With continued decline in enrollments, CS departments must pay attention to the learning environment if the percentage of women and minorities in CS is to increase. We describe a comprehensive, research-based intervention that is designed to enhance inclusiveness for all students—including women and minority students—by simultaneously addressing change in faculty and students and, as a consequence, increasing student commitment and retention.

Components of this intervention are likely to exert a synergistic impact on retention. Because there are multiple causes of women and minorities quitting IT study and careers, interventions intended to address these causes must be similarly complex. Moreover, interventions must be sufficiently flexible to allow their diffusion to educational institutions with different missions. The components of this intervention are broadly applicable and can be used to enhance inclusiveness and student retention in all areas of education.

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KEY TERMS

Active Coping: Process of taking initiative to remove or circumvent stressors or to reduce their impact.

Appreciative Inquiry: An approach to change that emphasizes optimism and challenge rather than deficits.

Historically Black College or University (HBCU): About one-hundred private and public colleges and universities created to educate African Americans starting in 1837 with the founding of Cheney University (PA).

Inclusiveness: Work and learning practices that emphasize involving rather than excluding others. This includes acceptance of diverse styles of learning and avoids actions based upon stereotypes concerning group membership.

Pair Programming: A programming practice involving two programmers working together; one partner acts as the "driver" and is responsible for writing code, while the "non-driver" partner is instructed to observe the work of the driver and watch for errors, consider alternatives, and provide feedback.

Realistic Career Preview: An individual change and socialization practice in which one is provided a realistic preview of an occupational future that includes both positive and negative features.

Stereotype Threat: The extra pressure that members of underrepresented groups such as women and minorities may feel caused by fear of confirming and reinforcing negative stereotypes held about their group, for example, they are not skilled in mathematics and science. This extra pressure can reduce performance and persistence.

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Environmental Context and Women in the IT Workforce

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INTRODUCTION

The rise of the network society involves a transformation of employment, in which power relations shift with the flow of capital, leading to downsizing, subcontracting and networking of labor. These processes facilitate flexibility and individualization of contractual arrangements in information work. As a whole, there is an increase in self-employment, temporary work, and part-time work, particularly for women (Castells, 1996). This transformation of employment brings heightened consideration about the characteristics of the labor force. Thus, one need is to examine environmental context and the possible connections between economic and cultural factors of a region and the experience of women in the IT workforce. This article summarizes an empirical study presented in greater detail in Trauth, Quesenberry, and Yeo (2005) that explored the influence of environmental context on women in the IT workforce by using the Individual Differences Theory of Gender and IT (Trauth, 2002; Trauth, Huang, Morgan, Quesenberry, & Yeo, 2006; Trauth, Quesenberry, & Morgan, 2004).

BACKGROUND

Previous research has shown that development of an information economy is highly dependent on environmental context factors (e.g., Benner, 2002; Castells, 1996; Kling & Turner, 1991; Trauth, 2000). Importantly, the development of these information economies has been shown to be the result of more than just technological infrastructure (Benner, 2002). The information economy in Ireland was the result of four groups of factors: infrastructure, public policy, economy, and culture (Trauth, 2000). Likewise, Kling and Turner (1991) argue that the development of an information economy is dependent on the number of information workers. Increased focus on information workers brings with it increased attention to gender representation in the IT workforce. Thus, it is critical to investigate the experiences of women in information work as their role has an increasing impact on the overall growth and stability of the network economy.

MAIN THRUST OF THE ARTICLE

This article reports on one aspect of a multi-year, multi-site, interpretive qualitative field study of women working in IT whose goal is to investigate the female under representation in IT. The guiding theory for this research is the Individual Differences Theory of Gender and IT proposed by Trauth (2002; Trauth et al., 2004, 2005, 2006) which examines the individual variations among women resulting from a combination of individual characteristics and environmental influences, in order to explain the under representation of women in the IT workforce.

Fifty-seven female IT practitioners were interviewed between October 2002 and October 2004. Eighteen of these interviews were conducted in Massachusetts, 25 were conducted in North Carolina and 14 were conducted in Pennsylvania. These women represent a wide range of ages, backgrounds, levels of management responsibility, and degrees of technical specialization. The racial make-up of the women includes Caucasians, African Americans, Asian Americans, Hispanics/Latinas and women from Middle Eastern descent. The interview data is also supplemented by participant observation data and by documentary data about gender and the IT sector in the regions involved in the study.

What emerged from the interviews are several themes about environmental context and women in the IT workforce. The following section discusses environmental context themes of economic and cultural factors from the three regions in the study: Boston, Massachusetts; Charlotte and the Research Triangle Park area of North Carolina; and central Pennsylvania. The cultural factors to be examined are: population migration patterns, ties to region, and attitudes towards women and women working.

Massachusetts Environmental Context

The Boston area is one of the wealthiest regions in the U.S. with a large and thriving IT economy. The information sector in this region grew steadily and boomed in 2001 with the employment of approximately 79,900 IT workers or approximately 4% of the overall labor force in the area. However, in 2003, the information sector showed a decline with the employment of approximately 64,100 IT workers or 3.4% of the overall labor force[1] (U.S. Department of Labor, 2004). In 2000, the national median value of owner-occupied housing units in the U.S. was $119,600 and 66.2% of the population owned a home. Also, in 1999 the national median household income[2] was $41,994 and the per capita money income[3] was $21,587. These figures are much higher in the Boston area. In 2000, the median value of owner-occupied housing units in the Boston area was $221,867 and approximately 55% of the city population owned a home. In addition, in 1999, the median household income was $54,536 and the per capita money income was $28,816. It is important to note that these figures are an average of three counties in the Boston area.[4] When examining statistics of affluent pockets of the Boston area, the figures are much higher (FedStats, 2005).

A noteworthy aspect of cultural context in Boston is the racial and ethnic diversity of its population. Much of Boston's population is comprised of racial and ethnic minorities including African Americans, Asian Americans, and Hispanic/Latino Americans in addition to Caucasian Americans (U.S. Census Bureau, 2000). The regional diversity is also represented in the interviews with women in this study. A number of participants noted the value placed on diversity and the open mindedness in the Boston region. As a result, many women felt it was easier to be a female IT worker in Boston than it would be in other geographical areas.

Several women also shared stories of how employers are proactive in creating a diverse IT workforce. These companies search for employees with a wide range of backgrounds, attitudes, and demographics in order to bring diverse people and mindsets to the workplace. Many participants also explained how employers value and devote significant amounts of corporate resources to diversity training. Furthermore, several women in the study felt that Boston is less hostile to women than other regions. However, even those women who said they did not personally experience hostility in the workplace did acknowledge that discrimination still exists. The women spoke about the difficulties associated with being a female in the IT workplace and succeeding in their careers. Many women shared stories of the challenges associated with moving into management positions and the need to rely upon characteristics—such as assertiveness—that are often socially defined as masculine.

Women constitute a large percentage of the labor force in the Boston region (U.S. Census Bureau, 2000, 2003). Many women in this study felt that being a female in Boston's IT workforce was not uncommon and therefore was not a central factor in workplace issues. Rather, these women felt that other demographic characteristics that they possessed, such as racial, ethnic and sexual orientation differences were more prevalent when workplace diversity issues arose.

North Carolina Environmental Context

North Carolina is undergoing a major transition from an economy based on agriculture and manufacturing to an economy based on IT and knowledge-intensive occupations. Two regions vital to this transition are Charlotte and the Research Triangle Park area. Charlotte is North Carolina's largest and most populated city. The information sector in North Carolina grew rapidly and boomed in 2001 with the employment of approximately 49,100 IT workers or approximately 3.6% of the overall labor force in the area. However, in 2003, the information sector showed a decline with the employment of approximately 46,300 IT workers or approximately 3.4% of the overall labor force in the area (U.S. Department of Labor, 2004). The median household income and the median value of owner-occupied housing units in Charlotte and the Research Triangle Park area is lower than the Boston region, but higher than the national average (FedStats, 2005).

Hanchett and Sumner (2003) explain that recruiting talent to North Carolina tends to be easy because of the area's reputation for an outstanding quality of life and a higher standard of living compared with other areas of the U.S. As a result, the population of Charlotte doubled between 1970 and 2000, making it the second fastest growing city in the U.S. with a population of 389,000. In addition, people from all over the country and around the world have relocated to Charlotte, bringing new ideas and customs with them. In Charlotte there are over 34,000 Asians (or 8.7% of the city population) and 60,000 Latinos (or 15.4% of the city population), which is an increase from 6,700 in 1990 (Hanchett & Sumner, 2003).

The move to an information age and the migration of people to North Carolina has occurred alongside the transition from what has been referred to as the "old south" to the "new south" (Hanchett, 1998). A majority of the participants spoke about this transformation in North Carolina. It appears in many ways that North Carolina is at a crossroads as the economic centers of the state transition from a traditional old south to a more progressive new south culture. Many regional norms, values, and attitudes appear to be in a state of flux as the area thrives economically and a new breed of North Carolinian populates the state.

The passing of the old south brings tension to the idea of a true southern belle and southern lady. A southern belle is described as a woman raised in "old-fashion southern values," and is typically associated with a family of social prominence and financial means. A southern belle is a woman with grace, manners, and strong family values. Participants in this study repeatedly discussed the concept of a southern belle and how that perception influences their lives and careers as women in the IT workforce in the South. Thus, there is a social expectation that southern women should be polite, well mannered, quiet when necessary, and place the highest importance on domestic roles even at the cost of a career outside of the home.

Most of the participants consider themselves to be "new south" women or southern Yankees and did not identify with the southern belle label. The majority of the participants reject the southern belle title because they place an importance on their career in the IT workforce and feel that the two concepts are in conflict. Several participants shared experiences of being treated as inferior or different from men in the IT workplace. Many women also felt that the regional culture contained an expectation that women act differently and more indirect in their workplace behavior. As a result, these women often felt it was a challenge to be assertive or to advance to higher levels of management.

In addition, several women in this study did not identify with the southern belle label because of geographical origin or race. Gina is originally from rural North Carolina, and explained that women from the mountain areas of the state are much different from southern belles. She felt that women from the mountain areas are much more independent and have a strong role outside of the home. Likewise, African-American participants in this study did not identify with the label of southern belles because of the radically different history of African Americans in the south.

Pennsylvania Environmental Context

The landscape of central Pennsylvania is often identified as the middle of the state excluding Pittsburgh and Philadelphia. Central Pennsylvania extends from the Southern Alleghenies along the Allegheny plateau and includes the cities of Altoona, Bloomsburg, Harrisburg, Johnstown, State College, and Reading. The information sector in central Pennsylvania has increased much slower than other areas in the U.S. with an employment peak in 2001 at approximately 46,700 IT workers or approximately 2.5% of the overall labor force in the area. In 2003, the information sector showed a decline with the employment of approximately 40,400 IT workers or approximately 2.3% of the overall labor force in the area (U.S. Department of Labor, 2004). The median household income and the median value of owner-occupied housing units in central Pennsylvania is much lower than that of Boston and Charlotte/Research Triangle Park (FedStats, 2005).

The women in this study explained that central Pennsylvania has a recent and growing demand for IT workers, but there is a shortage of skilled workers to fill these demands. As a result, many women felt it is easier to find IT work than some other kinds of jobs, so long as they have the necessary skills. Several women explicitly mentioned that their gender did not matter on the IT hiring market—it was technical skills that came first.

Yet, despite the lack of gender barriers to career entry, the women in this study shared stories of the difficulties they face as females in the central Pennsylvania IT workforce once they are hired. Many women felt they are continuously challenged and isolated in the workplace because of their gender. In order to compensate for these feelings, some women attempt to modify their behaviors to become more assertive.

Several participants also elaborated on how female participation in the IT workforce creates tension with regional cultural attitudes towards women working. The women in the study continuously referenced a regional cultural expectation for women to work and raise a family without filling a job intended for a male primary income earner. A few women shared stories of being passed-over for promotions or raises despite their exceptional work performance. Rather, the promotions and raises were given to male coworkers because they were considered to be the primary income earners for their families.

The aging population is a serious problem facing central Pennsylvania. Pennsylvania ranks second in the nation with residents over the age of 65 and ranks number one in the loss of young people aged 25 to 34 (Brookings Institute, 2003). In contrast to Massachusetts and North Carolina, the intransient nature of central Pennsylvania's population appears to create an environmental context in which newcomers feel like outsiders. Participants in the study who are not originally from central Pennsylvania felt like outsiders despite living in the region for several years. These women were attracted to central Pennsylvania because their skill sets were in demand, but continue to experience difficulties adjusting to regional norms, and building social and professional networks.

FUTURE TRENDS

This article contributes to discourse about the under representation of women in the IT workforce, in order to inform future research as well as diversity enhancement initiatives in the educational and employment arenas. Yet, an important caveat to this discussion of environmental influences is that these results are only an initial finding based upon data from three different geographical regions of the U.S. Future research will involve an additional round of interviews in each region along with continued collection and analysis of environmental context data.

CONCLUSION

These findings bolster an argument in favor of looking beyond the data at hand, to the women *in context.* As this article indicates, context might refer to state, province or region. Other work by Trauth shows that context can also be national context (Trauth, 1995, 2000; Trauth, Nielsen, & von Hellens, 2003). The argument for considering women's experiences in context challenges a prevailing tendency to generalize from one dataset to all women, everywhere.

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KEY TERMS

Individual Differences Theory of Gender and IT: A social theory developed by Trauth (Trauth, 2002; Trauth et al., 2004) that focuses on within-group rather than between-group differences to explain differences in male and female relationships with information technology and IT careers. This theory posits that the under representation of women in IT can best be explained by considering individual characteristics and individual influences that result in individual and varied responses to generalized environmental influences on women.

Information Economy: Also referred to as the *information sector*, this portion of a nation's economy encompasses the work and workers engaged in the processing of information and the production of information tools. The information economy is divided into two sectors. The *primary information sector* is responsible for producing information processing and communication hardware and software, and information systems and services. It also includes the development of content for these systems. The *secondary information sector* consists of those organizations which process information in the course of accomplishing some other mission (Trauth, 2000, p. 5).

Interpretive Research: Research directed at understanding the deeper structure of a phenomenon within its cultural context by exploring the subjective and intersubjective meanings that people create as they interact with the world around them (Orlikowski & Baroudi, 1991, p. 5).

Qualitative Research: A term used to describe forms of social inquiry that aim at understanding the meaning of human action and that rely primarily on qualitative data (e.g., data in the form of words), including ethnography, case study research, naturalistic inquiry, ethno-methodology, life-history methodology, and narrative inquiry (Schwandt, 2001, p. 213).

ENDNOTES

[1] These figures are based on the Boston Metropolitan Statistical Area (MSA) of Essex, Middlesex, Norfolk, Plymouth and Suffork counties.

[2] Median household income is the average income of all household members over the age of 15 (Fedstats, 2005).

[3] Per capita money income is the mean income of an individual for a geographic region. It is determined by dividing the total income of all people over the age of 15 by the total population of the area (Fedstats, 2005).

[4] These figures are based on an average of Middlesex, Norfolk, and Suffork counties.

Factors Influencing Girls' Choice of Information Technology Careers

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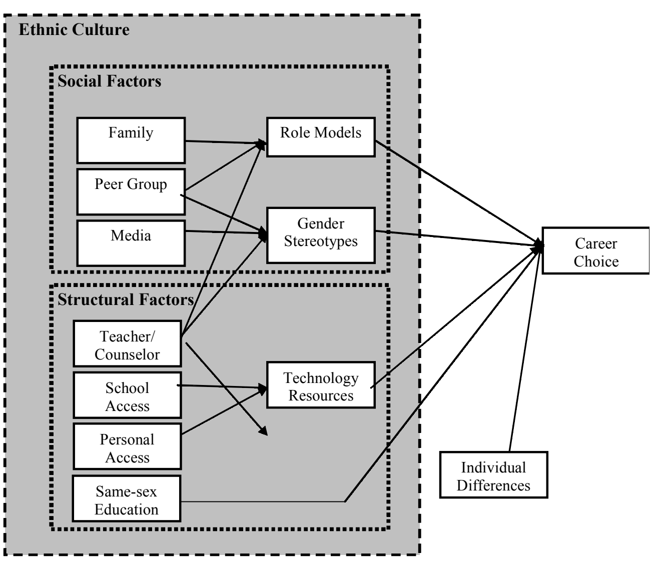
INTRODUCTION

Many western nations have experienced declining numbers of women in the information technology (IT) workforce (Trauth, Nielsen, & von Hellens, 2003). Between 1996 and 2002, women in the U.S. IT workforce declined from 41% to 34.9% (ITAA, 2003). This can hamper diversity and reduce the talent pool that can address needs of diverse end-users (Florida & Gates, 2002). Why do women choose IT careers or reject them? Multidisciplinary research on career genderization reveals gender imbalance (Trauth, Nielsen, & von Hellens, 2003). Career decisions against math, science, and technology (MST) are often made as early as age 11 without understanding long-term implications (AAUW, 2000). We examine influences on girls' choice of IT careers, modeling social, structural, and personal variables that affect IT career choice.

Using Ahuja's (2002) classification of social and structural influences on women's IT careers, Beise, Myers, VanBrackle, and Chevli-Saroq's (2003) model of women's career decisions, and individual differences suggested by Trauth (2002), we extend literature to children and adolescents' career choices. Social influences bias internal and external gender perceptions and stereotyping, role models, peers, media, and family. Institutional support such as teachers and counselors, access to technology, and same-sex versus coeducational schools are structural influences. While both can influence career decisions, social factors have the most influence on children's early perceptions. Both factors can introduce gender-stereotyping effects on career choices.

Figure 1. Factors influencing girls' career choices



Gender stereotyping explains how girls perceive their role in society based on subtle societal cues. It can limit opportunities for both sexes. We also examine personality traits and external influences that make children unique. Their individual differences draw them to activities and content areas such as problem solving and interaction with people. Finally, ethnic culture can exert an influence on social and structural variables. Figure 1 from Adya and Kaiser (2005) presents our career choice model that is discussed in the next section.

MAIN THRUST OF THE ARTICLE

SOCIAL INFLUENCES

Role Models

Career choices are influenced by role models who are often familial or educational rather than famous societal figures (Dryler, 1998). Direct forms of parental influence, such as the degree to which students see their parents choosing IT careers or having contact with technology, are strong motivators to train for technical jobs. Family members can also motivate career choices indirectly by encouraging girls to pursue careers perceived to be "masculine."

Women entering male-dominated fields come from families where mothers have four year degrees, mothers are working, both parents are highly educated, and success is considered critical (Jackson, Gardner, & Sullivan, 1993; Smith, 2000). Women choosing nontraditional careers recall fathers having a strong influence on career choices in nontraditional environments such as math, science, and technology (MST) (Gates, 2002; Trauth, 2002). Older brothers can influence girls toward "masculine" careers (Banks et al., 1992). Girls with only sisters chose careers that are more "feminine." Similar sibling influence is found for boys with male siblings.

Teenage peers have greater impact on social behaviors rather than career choices. During adolescence peer influence, particularly of boys on girls, impacts female self-concept, self-efficacy, classroom experiences, and external goal orientation. Such changes cause a clear demarcation between boys' and girls' career choices despite that girls score well on national level testing (Leslie, McClure, & Oaxaca, 1998). Among women, male peers play an important part in choice of MST as a career (Smith, 2000). Brekke (1997) on the other hand, attributes lack of participation in college-level physics to result partially from peer pressure that steers students away from MST.

Media

Media enhances gender stereotypes that emphasize physical image. Although girls interpret such images as unrealistic, they conform due to social pressure (Milkie, 1999). The few women shown in computer magazines, textbooks, and software are usually represented stereotypically (Na, 2001). Media does not depict women in positions of power or as active computer users. Analysis of television advertising reports males with central, authoritative roles having more credibility than women regarding product knowledge. Women are shown against the backdrop of children (Na, 2001). Trade journals and media may have changed for young adult women showing them in professional roles but young teens do not read these. Seventeen and Cosmo Girl, the two most popular teen magazines, have little content that portrays women in technology careers.

Gender Stereotypes

Girls' perceptions of IT jobs may mirror stereotypes that do not represent the dynamic and rewarding nature of the field (von Hellens, Pringle, Nielsen, & Greenhill, 2000). The Rhode Island Economic Policy Council (2000) reported that teenagers considered IT "uncool, nerdy, or boring." Steele (1997) found that gender stereotypes against female computer use negatively affected self-concept and career choices. Math has been stereotyped as masculine and is a critical filter that deters women from MST careers (Beise, Myers, VanBrackle, & Chevli-Saroq, 2003).

Beliefs about role-appropriate behavior restrict choice of careers in college. Up to age ten, girls have similar subject interests as boys and are perceived to be better at all or most subjects than boys. As career choices form, girls begin narrowing their career options, often excluding MST (Miller & Budd, 1999). These decisions are lifetime decisions that reduce opportunities to pursue technology careers.

What causes gender-biased perceptions of technology careers? Parental, teacher, and peer role models can carry hidden messages about boys' and girls' capability with computers (Volman & van Eck, 2001). Children whose parents have higher levels of education resist gender stereotyping while those whose parents have high school or less conform to gender stereotypes (Bouchard & St-Amant, 2000). Parents with stereotypical math perceptions impact girls' self-perceptions about their math ability and success.

STRUCTURAL FACTORS

Structural factors represent institutional support available to women to pursue careers. The role of teachers and counselors in exposing students to technology, access to computer technology both at home as well as in schools, and the nature of the school environment can influence genderization or neutralization of IT careers.

Teacher/Counselor Influences

Research uncovers negative influences of teachers and counselors on MST career choices reflecting a gender bias in directing girls towards traditional careers (Gates, 2002; Turner, Brent, & Pecora, 2002). However, women who moved from non-IT to IT careers indicated male professors as a strong influence (Canes & Rosen, 1995). Teachers stereotype roles by giving the impression that boys are inherently better with computers than girls. Teachers, both male and female, attribute certain expertise to boys and give them priority for computer use (Volman & van Eck, 2001).

Counselors devote little time on occupational and job counseling, ranking it fifth out of eight functions they typically perform (NCES, 2003). Since only 29% of girls receive support from career counselors, the amount of counseling is minimal. Moreover, middle and high school teachers and counselors are more comfortable advising toward traditional fields possibly because they lack IT background (Freeman & Aspray, 1999).

School Technology

Women IT professionals cite school access to computers as a prominent reason for interest in IT (Turner, Brent, & Pecora, 2002). School computer access has increased significantly but reports on gender differences in its use have been mixed. Durndell & Thomson (1997) report that differences in use of computers at school are non-existent or declining. Huber & Schofield (1998) observe more frequent and diverse use of computers by boys than girls.

Only 60% of teachers reported using computers for instruction, 41% assigned computer tasks, while 23% felt prepared to use computers and the Internet (NCES, 2000). Teachers who felt technologically prepared were more likely to use technology in class and assign materials requiring computers for problem solving and data analysis. The current generation of teachers, while knowledgeable about computer use for personal productivity, may have limited knowledge about IT career choices.

Home Technology

Boys use home computers more frequently than girls and are more likely to own computers or be prominent users of shared computers (Harris, 1999). They use computers more than girls as a social activity (Durndell & Thomson, 1997). Boys demand more power and functionality from home computers (Habib & Cronford, 2002). Students with home computers have significantly more positive attitudes towards IT in college (Selwyn, 1998).

Perceived usefulness and attitudes about computers are key determinants of IT usage intention and behaviors (Venkatesh & Davis, 2000). While increased technology access familiarizes children with computers, nature of use may influence beliefs and attitudes about technological careers. Although gender gap in technology access is non-existent, use of computers and the Internet is not. Boys use the Internet for a wider range of activities such as games, shopping, and finding information while girls restrict Internet use largely for e-mail and access to educational resources (NCES, 2002). Women exposed to play and collaboration-based assignments in training are more likely to choose MST careers (Smith, 2000).

Same-Sex vs. Co-Educational Schools

Sex-segregated environments inadvertently reinforce gender stereotypes, squander opportunities to address gender inequity, and expose students to teasing from peers in co-educational classes (Viadero, 2001). School environment has no impact on senior students from public schools with regard to math (Vezeau, Bouffard, & Chouinard, 2000). Students attending same-sex high schools have minimal pressures from the opposite sex and have a better sense of belonging (Brutsaert & Van Houtte, 2002; Watson, Quatman, & Eder, 2002). If high school experiences reinforce notions that boys adapt better to technical areas, same-sex students have no comparisons (Jackson, 2002). One might expect that students of same-sex schools would not embrace gender-specific career choices. Although structural factors may exert similar influences in same-sex and co-educational schools, peers may impact differently.

INDIVIDUAL DIFFERENCES

An emerging theory that challenges the essentialist (Venkatesh & Morris, 2000) and social construction (Adam, 2002) perspectives of gender and IT suggests that individual differences play an important role in forming career choices (Trauth, Quesenberry, & Morgan, 2004). It suggests that the socio-cultural environment of women shapes their individual responses and experiences as IT professionals. Many individual differences are split along gender lines (Trusty, Robinson, Plata, & Ng, 2000). Personality traits, enjoyment of computers, and overall outlook are some characteristics accounting for these differences. Women in IT reported several personality characteristics that made them different—powerful, forthright, strong, ambitious, driven, mathematical, logical, and less social than other girls (Trauth, 2002). Although female students enjoy using computers less than male students and perceive more problems with software, IT career women report higher levels of enjoyment with computers (Turner, Brent, & Pecora, 2002). Such factors may impact occupational choices at young ages.

ETHNIC CULTURE

The under-representation of women in the IT workforce is global but appears more severe in developed nations (Trauth, Nielsen, & von Hellens 2003). These studies find that women from India and China have more positive attitudes towards MST careers. Although both India and China represent similar economic environments, they represent a broad population that excels in MST careers. While market demands shape workforce trends, ethnic culture may provide more positive MST career orientations to women in these countries (Trauth, 2002). The lack of research suggests that cross-cultural examination of structural and social factors requires further investigation.

FUTURE TRENDS

Three decades of research may not reflect how IT pervades homes and schools today. Home computer use is equally divided between male and female users (NCES, 2002). Technology is being increasingly integrated in school curriculum and education and the popularity of Internet gaming and instant messaging can reduce a gender-based digital divide (Gorriz & Medina, 2000). Increasing number of women in the overall workforce and the knowledge that technical education is critical to success are other social trends that can promote the need for technology education.

Offshore software development in some countries emphasizes IT more than before. The U.S. is projected to face a shortage of 2 million IT professionals by 2006 but not enough students are graduating to fill this gap (O'Hara, 2000). India's emphasis on quality and its strong educational system has encouraged unprecedented software growth (West & Bogumil, 2001). Such market changes make IT a very attractive career, which in turn can affect families' work habits, education, and interactions. Will these trends make IT a more attractive field to the next generation?

CONCLUSION

Declining numbers of women enrolled in IT curricula and the workforce should motivate IT educators and policymakers to improve programs conducive to technology careers. Before teachers can provide gender-neutral counseling, they themselves need training in technology and its career options. Teachers and counselors can benefit from increased interaction with industry and universities as well as ongoing technological training.

Parental involvement clearly has a positive bearing on choice of IT as a career. As fathers continue to influence girls' career choices and mothers get involved in the workforce, educating parents about IT career options is important. The misperception of what IT professionals do and what skills they need to succeed can deter many college students from choosing IT. Improved marketing may alter these misperceptions. The technological outlook today is changing for the better. If we can successfully identify and manage student IT career perceptions during adolescence, women may increasingly populate the IT workforce and college level programs.

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KEY TERMS

AAUW (American Association of University Women): Organization promoting equity for women and girls' education, and societal change. (http://www.aauw.org/)

Digital Divide: Demarcation between those who have access to technology and those who do not.

Ethnic Culture: Of or relating to large groups of people classed according to common racial, national, tribal, religious, linguistic, or cultural origin or background (Webster).

Gender Stereotyping: Making assumptions about one gender; generalizing or attributing characteristics to all people of that group.

Individual Differences: Unique characteristics applied to a person.

ITAA (Information Technology Association of America): Trade association of IT firms. (http://www.itaa.org/)

NCES (National Center for Education Statistics): U.S. government organization for collecting and analyzing data about education. (http://nces.ed.gov/)

Role Model: A person whose behavior in a particular role is imitated by others.

Factors that Influence Women and Men to Enroll in IT Majors

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INTRODUCTION

Because of the ubiquitous nature of information technology, there is a continuous need for IT professionals. There has been a steady growth in the information technology industry as well as an increase in the use of information technology. However, the number of qualified technology workers has not kept up with the demand for technology-skilled labor. One reason for the workforce shortage is that women are underrepresented. Not only are there many fewer women in the IT workforce, but there are fewer women entering and graduating from traditional technology-related academic programs like computer science (CS), computer engineering (CE), and systems science. In 1986, approximately 36% of the U.S. graduates in CS and CE were women; in 2004, 17% were women (Bryant & Irwin, 2001; Carver, 1999; Zweben, 2005). Of those earning doctoral degrees in 2004 only 18% were women (Zweben, 2005). Given that 51% of the total population is women, these statistics give a vivid explanation of why there is a shortage of IT workers.

BACKGROUND

In the United States in 1999, four core IT occupations—computer scientists, computer engineers, systems analysts, and programmers—employed over 2.2 million people (United Engineering Foundation, 1999). In 2004, only 0.3% of incoming freshman college women and 2.8% of men expressed an interest in majoring in computer science, according to the Higher Education Research Institute (n.d.). The numbers of students interested in engineering are also down despite U.S. Commerce Department reports that show 70.2 % of all vacant positions in science and engineering between 2002 and 2012 (a total of 1.6 million jobs) will be in information technology. All programmers and others who work in IT professions do not have university degrees; however, education remains a critical factor in preparing the IT workforce. In 2002, the number of students pursuing doctorates in computer science in the top 50 U.S. research universities fell to the lowest number in 12 years (Foster, 2005).

The small (and declining) numbers of women enrolling in IT-related degree programs in universities should be a cause of concern (Kossuth & Leger-Hornby, 2004). Parents of daughters might be concerned because high-paying IT jobs are not available to young women without academic credentials. Industry managers could be concerned that the underused potential of women professionals limits needed skills in the IT workplace such as organizational expertise, an understanding of customer service, and the ability to work collaboratively. With inadequate preparation for the IT field, women can miss out on opportunities for creative work, the chance to influence the IT field, and professional work that can be financially rewarding.

With limited numbers of women in positions in which software is being created, the female perspective in software products will be underrepresented. The consequence is that girls and young women may be less interested in the field of technology because the software, games, technology products, and so forth do not appeal to them.

FACTORS THAT INFLUENCE ENROLLMENT IN IT MAJORS

Career Interest

Although it is fairly common today to have more than one career in a lifetime, the choice of a university discipline and the subsequent career is one of the most important decisions that one will ever make. Men and women choose careers based on several cognitive and affective factors including the following:

- Deeply held values
- Self-knowledge
- Knowledge of careers (Niles & Harris-Bowlsbey, 2002). There are also societal factors that influence career choice. As Margolis and Fisher note (2002), women often express an interest in a balanced lifestyle that may include having children and giving attention to home and family. When they see computer science and other technology-related careers as requiring a singular focus on sitting at a computer and programming all day and far into the night, the cost is too great for them.

An academic major is often related to the career a student will pursue after graduation. In a study intended to learn what students and teachers viewed as effective recruitment techniques and the factors that influence students to enter technology education programs, students indicated that they decided on a major while in high school rather than waiting until entering the university (Gray & Daugherty, 2004). Students may change their minds once they are at the university level, but many make the decision before applying to and matriculating in a university.

IT Career Choice

What are the factors most likely to influence a student to choose to enroll in an IT-related major? There is a strong connection between the quality of science and mathematics teaching and success in these subjects in high school and a student's interest in majoring in science and/or engineering. In a six-nation study (Australia, Canada, China, England, Japan, and Portugal), Woolnough and Guo (1997) found that science and math teaching had to be supportive, at an appropriate level of difficulty, and intellectually stimulating in order for students to be influenced to study the subjects at the university level. Secondary students in the study were also influenced to major in science and/or engineering (considered a traditional IT-related field) when they were involved in science competitions, had science-related hobbies at home, and perceived science and IT-related professions as satisfying, bringing high status, and having good salaries.

Success in mathematics in primary and secondary school is often seen as an influential factor in becoming interested in computer science and other information technology-related subjects. Computers by their very nature are computational, and the study of computing in precollege programs has often resided in mathematics departments. In a study that examined students' perceived ability in mathematics, researchers found that gender, years of high school mathematics, math self-efficacy, and math anxiety predicted choice of a science- or math-related college major (Hackett, 1985).

A Brazilian study of high school students found five underlying factors related to students' choices of an undergraduate major. The five factors that were found to be significant after interviewing over 1,000 senior high school students included liking the activity, family members' influence, previous experience in the field, access to information about the field, and the state of the job market. The researchers found that males mentioned family influence most often, and female students mentioned liking the activity related to their intended college major most often (Alchieri & Charczuk, 2003). In Ireland, McQuillan and Bradley (1999) conducted a study of 91 19-year-old first-year female university students to learn about women's underrepresentation in computing majors and careers. They found that women students were influenced to choose computing-related majors through career advice, university-based communications, the promise of excellent career prospects, the encouragement of family members, an interest in computer technology, and generic reasons such as the belief that computers are the way of the future. The results of this and other international studies outlining influences on selecting a major are summarized in Table 1.

In a study supported by the U.S. National Science Foundation, researchers at Rutgers University interviewed 41 men and women undergraduates enrolled in IT-related majors to determine the factors that influenced them in the choice of an IT major and career. The students from computer science, computer engineering, and information technology and informatics (ITI) listed the following as influential in their decision to study information technology.

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Table 1. A summary of selected research studies on factors that influence students to choose a university major

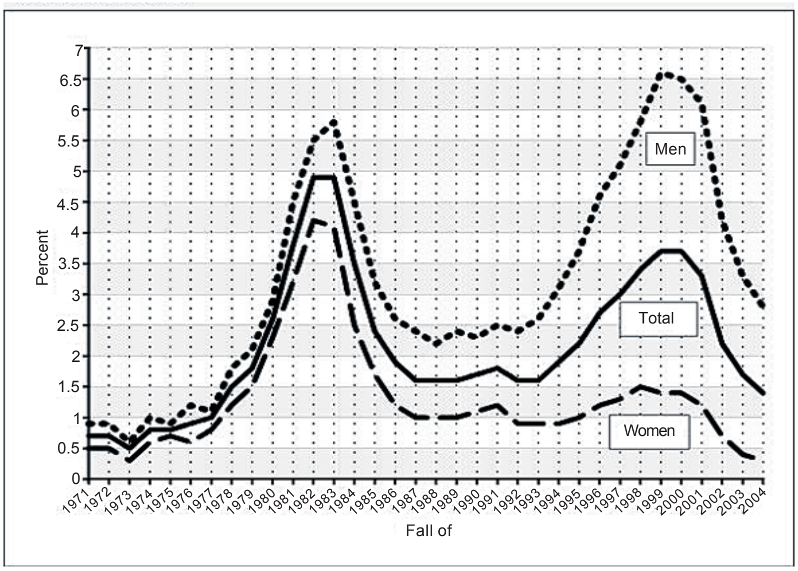
Country Context of Study	Authors	Education Level of Students	University Major	Factors that Influence Students to Choose a University Major
Australia Canada China England Japan Portugal	Woolnough & Guo (1997)	Secondary school	Science or engineering	- Involved in science competitions - Worked on science hobbies at home - Perceived science- and IT-related professions as satisfying - Viewed IT-related professions as having high status and good salaries
Brazil	Alchieri & Charczuk (2003)	Secondary school	Any university major	- Liked the activity - Was Influenced by family members - Had previous experience in the field - Had access to information about the field - Was aware of the state of the job market
Ireland	McQuillan & Bradley (1999)	First-year women university students	Computer science	- Read about computing in college prospectus - Heard about computing on college-information day - Was influenced by career advice from a teacher - Knew of good career prospects - Was encouraged by family members - Was interested in computing

- Were encouraged by family members and friends
- Liked mathematics
- Experienced success in mathematics
- Liked working with computers
- Experienced success in working with computers
- Liked the people-centered nature of the major (ITI students)
- Liked the multifaceted curriculum (ITI students)
- Completed an advanced placement (college level) computer course in secondary school
- Completed and enjoyed an IT-related course in secondary school
- Liked programming
- Liked working with hardware
- Liked the challenge of working with computers
- Anticipated good job opportunities
- Anticipated a good salary
- Anticipated a job with prestige
- Had a job in the IT field while enrolled in high school or college (McInerney, O'Donnell, DiDonato, & Giagnacova, in press)

Some students were employed in part-time paid positions in high school or college in which they worked with computers or computer applications, or solved computing problems, and success with this work influenced the student to enroll in an IT major. Students in the ITI major indicated that they liked the human factor emphasis and multidisciplinary nature of the major in which they were enrolled.

Although, as Foster reports (2005), the interest in traditional IT careers may be dwindling, there is still a fascination with technology that propels students to choose an IT-related undergraduate major. The numbers of students interested in a traditional CS major from 1990 through 2004 in U.S. universities are shown in Figure 1. The peaks and valleys of interest shown here seem to reflect social, cultural, and economic influences on choice of academic major. One can see that interest in computer science ballooned in the early 1980s when personal computers first became practical, affordable, and available for home and business desktop use. The next peak of interest (as indicated in Figure 1) came during what is commonly referred to as the dot-com

Figure 1. Percentage of probable freshman computer-science majors in U.S. universities (Source: Higher Education Research Institute; Vegso, 2005)



bubble in the late 1990s and early 2000s when there was a boom in the U.S. computer industry. As indicated, the numbers of women interested in enrolling in CS continue to be considerably lower than those of men. Even though common wisdom would dictate that the numbers of men and women enrolling in CS majors would even out over time, as they have in medical and law schools, that is not the case; the number of women in CS departments continues to decline.

IT Majors and Career Choices for Women

As statistics show through the trajectory of computer science majors in U.S. universities (Foster, 2005; Nelson, 2004; Vegso, 2005), the number of computer science majors is decreasing and the number of women majors in the field is dropping dramatically. Before career development interventions can be taken to encourage more women to consider IT, it is useful to examine the factors that encourage women to enter technology fields either while enrolled as students or as they enter the workforce.

Mentoring

Mentoring and modeling are strong influences on women who are seeking a career field (Catalyst, 2001). McQuillan and Bradley (1999) studied university women and technology in Ireland and found that role models provide powerful lessons and learning opportunities for female students. Unfortunately, though, there are limited numbers of women role models in the ranks of science and IT professors on university campuses. In the report on the status of women in computing science by a committee of the Association of Computing Machinery, one of the four primary challenges found for women who attempt to become computer scientists is the lack of mentoring and role models. As the report attests, "Mentors play a crucial, though usually informal, role in the training of young computer scientists" (Pearl, Pollack, Riskin, Thomas, Wolf, & Wu, 1990, p. 6). It is desirable for women to have female role models and mentors, the report continues, and any institution truly interested in encouraging women in technology must consider the provision of mentors and knowledgeable advisors in technology education and career counseling.

Work Experience as an Influence on Education and Career Choice

Another influence on choosing an academic field and ultimately a career is the opportunity to acquire hands-on work experience in a discipline. Research shows that the success of work-based learning depends on the structure of the experience. The cases in which work experience enhances students' education both academically and socially are those that develop practical skills and build confidence. In one study, internships at a university research lab succeeded in teaching lab techniques for DNA research while allowing students to apply chemistry and math knowledge learned in school (Stasz & Kaganoff, 1997). Internships and successive classes with the same teacher also help expose students to relationships with adults that nurture their self-confidence personally and within a field. One hypothesis related to choosing an IT career is that work experience in computer or other information technology laboratories on university campuses may influence students to choose to enter the IT workforce. According to Holland (1997) and Niles and Harris-Bowlsbey (2002), apprenticeships and internships can be important steps in the career decision-making processes.

Success in Secondary School and College

In their research with computer science majors in a top-ranked university computer science department, Margolis, Fisher, and Miller (2000) report that young women can develop a love for programming and IT through a successful experience in an advanced placement (college level) programming course in high school as well as through part-time computing-related employment. This love of programming often leads to a decision to major in computer science. Young women also discover a love of computing early on when they experience success in mathematics and science, and find that they enjoy solving puzzles, the art of logical and systematic thinking, and other intellectually challenging tasks. One gender difference researchers found is that women students often contextualize their interest in computing. Forty-four percent of the women studied saw computing as integrated with other experiences in human life and domains such as "medicine, space, and the arts," whereas only 9% of the men thought of computing this way (Margolis, Fisher, & Miller).

Self-Efficacy in Science and Mathematics

There is a strong connection between success and interest in science and mathematics and success in the study of computer science (Wilson, 2002). Wilson found that having a math background was the second most important factor in predicting success in academic computing. The most critical factor in computing success according to Wilson (and one supported by Margolis & Fisher, 2002; Pearl et al., 1990) is how comfortable students are in a computer science course. The comfort level is closely associated with self-efficacy. Women students can be confident and enthusiastic about enrolling in computer science majors, but when they encounter a hostile environment or one in which it seems that most of the other students have more experience with computing than they do, they often become unsure about their own abilities and quickly lose confidence and interest in IT.

Even though there has been an enduring relationship between self-efficacy in science and mathematics and an interest and aptitude in computing, the broad range of activities associated with information technology today can attract students with varied interests. Computer art and design, health monitoring and epidemiology informatics, technology-assisted learning, linguistic analysis, population tracking, and geographic information systems can all appeal to men and women with strengths in the humanities and social sciences.

FUTURE TRENDS

The number of information technology majors is declining, and the field continues to be one of the most inequitable among university majors. At the same time, the need for technology professionals continues. Outsourcing jobs, the uncertain economy, a "nerdy" image of the field (BBC News Online, 2001), the lack of mentors, a working environment that can seem unsafe (Pearl et al., 1990), and dual work-family issues (Machung, 1989; Pearl et al.,

1990) are all negative factors that present barriers for potential IT professionals. Margolis and Fisher (2002) acknowledge that change can happen, however. In 1995, 7% of the computer science freshmen at Carnegie Mellon University were women, but in 2000, the number of women rose to 42%.

Steps can be taken to improve the balance between men and women in IT including the following suggestions offered by the researchers at Carnegie Mellon.

- Admissions policies do not have to favor students highly experienced in IT if programs are available to allow inexperienced students to succeed.
- Attention needs to be paid to good teaching.
- Using introductory courses as "weed-out" experiences discourages students.
- IT curricula should contextualize the subject to apply to real-life situations.
- IT needs to move away from being viewed as promoting the hacker culture ideal; faculty can help by including students in their own research.
- Because so many students decide on their major in high school, universities need to reach out to faculty, staff, and students in secondary schools.

CONCLUSION

This discussion has reviewed the literature and research on influential factors in the choice of information technology-related university majors that lead to IT careers. Attention has been paid to women because they are underrepresented in information technology departments and professions. Although the situation is far from equitable, research continues on how university IT departments and IT workplaces might become hospitable and attractive to both men and women. It is beneficial to society and to the national interest to have a robust and educated IT workforce. Despite the trend toward downsizing and outsourcing, competent, creative, and innovative IT workers are the foundation of a solid information technology industry and an effective IT infrastructure for all.

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KEY TERMS

Career Development Interventions: Steps that can be taken to help individuals develop an interest in a certain career. These actions can include counseling, apprenticeships, observing professionals in that career at work, and discussing the career with those experienced in the workplace.

Information Technology: As defined by Carver (1999), it is "the study, design, development, implementation, support, or management of computer-based information systems" and includes "all production and all applications of hardware and software."

Information Technology Careers: In the United States, they are generally considered to be computer scientists, computer engineers, systems analysts, and programmers. These are the professions in which individuals create new products, design systems, produce and customize software, and manage and implement technological innovations. Admittedly, there are many other kinds of jobs in which people use technology tools.

Information Technology Majors: They are generally considered majors in computer science, computer engineering, and information systems. These majors often focus on programming, product design, software development, and system analysis and design.

Mentors: Individuals who are usually teachers, family friends, or professionals who are influential in encouraging individuals in their academic study and career aspirations. Mentors are especially important for girls and women who are underrepresented in the academic departments and careers of mathematics, science, and technology.

Nontraditional Technology Majors: They are often developed as alternatives to traditional IT majors. Majors such as information technology and informatics, information management, and technology applications can include courses in programming, but they also include courses in human factors and people-centered subjects such as human information behavior, information policy, information retrieval, and social informatics.

Self-Efficacy: How one feels about one's abilities in a particular skill area. High self-efficacy refers to confidence and the perception of success. Low self-efficacy indicates a feeling of failure or lack of achievement or success.

A Faculty Role in Women's Participation in Computing

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INTRODUCTION

The success of efforts to attract and retain more women in computing is influenced by many factors that are beyond the control of academic departments. Industry downturns, public perception about job opportunities and the desirability of a computing career, and gender stereotypes about interests and abilities are only a few contextual features that are likely to be relevant but over which computer science programs have little or no control. Nevertheless, there are ways that departments can have a measurable influence over women's representation, and several of those ways depend on faculty.

Women's portion of undergraduate enrollment in computing majors is low on average, but it varies across institutions (Cohoon, 2006). Likewise, women's portion of attrition from computer science (CS) is a disproportionately high rate—32% annual attrition of women from the major. Comparing women's attrition rate to men's attrition rate in the same department shows that on average, undergraduate women switched out of the CS major at a rate six points higher than their male classmates. However, just as some departments enroll higher proportions of women, there are also some undergraduate computing departments that retain men and women at comparable rates. The first part of our discussion examines the faculty behaviors that distinguish undergraduate departments that retain women.

Women's portion of graduate enrollment in computer science and computer engineering (CSE) is also low, but similar to undergraduate programs, it varies by department—from 8% to 33%. The second part of our discussion examines the faculty behaviors that distinguish graduate departments that enroll women.

In this article, we take a department-level approach to identifying factors that are related to the gender-balance of post-secondary computing. We examine the considerable role that members of a department's faculty play in bringing about similar outcomes for men and women. First, we discuss faculty actions that can affect retention in undergraduate computer science programs, and secondly, we discuss faculty recruitment of women into graduate CSE programs.

BACKGROUND

Until recently, research on women's participation in post-secondary computer science was scant. As a result, much of the background literature for investigations on this topic consists of research on women's participation in science, technology, engineering, and mathematics (STEM). Overall, this body of literature shows strong evidence for the important role that faculty play in women's participation in STEM disciplines. For example, a comprehensive review of intervention programs designed to promote women and underrepresented minorities in STEM found positive outcomes when faculty play an active role in recruiting and supporting students (Building Engineering and Science Talent, 2004). Women in fields with high status rewards, such as computer science, are less likely to experience the supportive environments that they find satisfying (Hearn & Olzak, 1981). In addition to being dissatisfied, women who find the classroom climate in engineering to be unsupportive tend to have low class participation (Salter & Persaud, 2003). However, supportive interactions with individual faculty can compensate for an environment that might otherwise be unsatisfying (Hearn & Olzak, 1981). Further evidence identifies some specific supportive faculty behaviors and the benefits they offer women students.

Mentoring activities range from social and emotional support to instrumental support (e.g., showing students how to write grant proposals and get articles published, writing letters of recommendation, etc.). These activities increase students' academic self-confidence, academic success, and career commitment in STEM fields. For example, a survey of more than 300 graduate students at a single university (Ulku-Steiner, Kurtz-Costes, & Kinlaw, 2000) showed that when faculty provided students with both affective support (such as sensitivity to students' non-academic commitments) and instrumental support (such as finding financial aid), students' academic self-confidence and career commitment increased. The association between mentoring and these outcomes was strongest for women in disciplines where the majority of faculty members were men. This was the group of women who had the lowest level of self-confidence. The boost in confidence that mentoring provides could be one reason for the measurable improvement in academic performance and continued enrollment at an institution associated with mentoring. The mentored students in this university's three-year study earned 0.3 of a grade point average higher than non-mentored students who entered the study institution at the same time with the same sex, ethnicity, and high school GPA (Campbell & Campbell, 1997). The mentored students in this study were also less likely to drop out of their institution. The evidence from these studies demonstrates that mentoring students is one way that faculty members can improve student outcomes. Whether the outcomes benefit women in particular is not clear.

There is evidence that instrumental mentoring benefits women graduate students in STEM fields. A national study of chemistry, computer science, electrical engineering, and physics graduate students showed advisor support was related to female enrollment (Fox, 2001). Women's representation was higher in programs where women reported more advisor support than reported by women in other programs. This support included instrumental mentoring activities such as advisor help with "learning to design research, to write grant proposals, to coauthor publications, and to organize people" (Fox, 2001, p. 659). The women in departments where these mentoring-type interactions were more common also had higher expectations of graduating than women in departments where it was less common for faculty to provide such help. This association between graduate women's participation in STEM disciplines and instrumental mentoring by faculty demonstrates one way that faculty members can influence the gender composition of their programs.

Another way faculty members influence the gender balance of STEM programs is through role modeling. Role modeling is frequently confused with mentoring, but is actually a different function. In contrast to the more active mentoring, being a role model involves serving as an example of the attitudes and behaviors related to a role. Furthermore, role models do not need to personally interact with students to be effective. Their importance lies in the assumption that observing a person similar to oneself in a role increases one's ability to imagine oneself in a similar role. The paucity of women role models has often been cited as an important reason for the small number of women students in computing (Teague, 2002; Townsend, 1996).

Unlike mentors (Cohoon, Gonsoulin, & Layman, 2004), role models are most effective when they are socially similar to the observer. For example, course retention was higher for first-year women who were taught mathematics and science by female faculty (Robst, Keil, & Russo, 1998). This finding is particularly interesting because the impact of faculty gender was greatest in classes where there were few women students, as is often the case in CS. Similar results from a study of graduate students show that being the same sex as the observer is important but not sufficient for role models to be effective (Etzkowitz, Kemelgor, Neuschatz, & Uzzi, 1994). Interviews with faculty and graduate students in physics, chemistry, electrical engineering, and computer science at a single research university found that characteristics other than sex were important. In particular, women graduate students wanted to model themselves after women who balanced work with their personal lives. Thus, it appears that being female is not an adequate condition for effective role modeling, and that some behavioral attributes are required for female role models to improve the retention of women in STEM.

In addition to mentoring and role models, other types of supportive student-faculty interactions influence women's participation in post-secondary STEM disciplines. For example, a multi-institution study with in-depth interviews of undergraduates found that faculty support through a crisis of confidence can retain undergraduates in STEM majors (Seymour & Hewitt, 1997). When students experience a crisis of confidence, an incident that is particularly common among women (Beyer, Rynes, Perrault, Hay, & Haller, 2003), faculty intervention can prevent attrition from the major.

Thus far, we have discussed findings related to *retention* in STEM. Retention is an important part of student participation, but it can only go so far toward increasing women's representation. More women must be recruited if their representation is to approach parity, but there is little research that identifies successful methods for recruiting women at the undergraduate level. For example, role models do not appear to be an effective means for attracting more women to STEM fields. Panel data from three institutions produced no evidence that increasing the number of female faculty generally translated into more female majors (Canes & Rosen, 1995).

The rare case of effective recruiting is Carnegie Mellon University (CMU). CMU dramatically increased the proportion of women in their computing program through a set of interventions that included outreach to high schools (Margolis & Fisher, 2001). The CMU experience suggests that vigorous recruiting of women can increase the number of women enrolled. Deliberate recruiting, such as that done by CMU, is more common at the graduate level than at the undergraduate level, and it requires support from the administration as well as cooperation from faculty members.

Student progression to graduate school can result from recruitment, and it can result from action taken by undergraduate faculty. Undergraduate faculty members who encourage students and help them understand quality research promote student continuation to graduate programs in pharmacy (Gagnon & Cocolas, 1988; Henderson & Keeney, 1988). We will report on similar findings for students in computing.

In sum, the evidence from STEM disciplines indicates that faculty members can influence student outcomes and the gender composition of their programs. Active recruiting, role modeling, and support in the form of mentoring lead to women's satisfaction, class participation, academic confidence, better grades, career commitment, retention, and progression to graduate school. We will describe related findings for women's retention and progression to graduate school in computing in the next section.

MAIN THRUST OF THE ARTICLE

The main thrust of this article is that computing faculty can exercise measurable influence over women's participation in computing. This influence can be applied at the undergraduate level both to retaining women and advancing students to graduate study. Less is known about the graduate level, but it appears that faculty can influence the gender composition of their program through activities that recruit women.

Retaining Undergraduate Women in Computer Science

Recent evidence demonstrates that there are many ways computing faculty can promote women's retention. When they create an environment that compensates for our culture's lack of support for women in computing, faculty overcome the social forces that inhibit women's participation in postsecondary computing.

Two of our large-scale studies demonstrate the effect that faculty mentoring of undergraduates has on women's retention in computer science. A statewide study of 23 computer science departments in Virginia suggests that faculty mentoring can help alleviate the loss of women in undergraduate programs (Cohoon, 2001). This survey of faculty and analysis of attrition by gender found that departments retained women at comparable rates to men if faculty members mentored their undergraduate students. The subsequent nationwide study confirmed the value of mentoring and specified that faculty motivations for mentoring play an important part in gender-balanced retention (Cohoon et al., 2004). The value of mentoring for students in general will be discussed in the section on graduate programs. In this section, we discuss the effect that mentoring and other faculty behaviors have on retention.

The relationship between mentoring and gender-balanced retention depends on faculty motivations for mentoring particular students. Our nationwide study showed that when mentoring is motivated by a desire for diversity, undergraduate women were retained at similar rates to their male classmates. Unfortunately, fewer than 30% of responding faculty members were even slightly motivated to mentor by the desire for diversity. Their most common reason for mentoring was "superior student ability" (Cohoon et al., 2004). This focus on exceptionally able students was less common among women faculty members, who were more likely than men to mentor women undergraduates in order to promote equal representation. Regardless of a mentor's sex, the results of diversity-motivated mentoring were the same for male and female mentors—female retention in computing was closer to male retention.

These studies also show other ways that faculty actions influence women's retention in undergraduate CSE. In particular, encouraging students and emphasizing homework and academics over extra-curricular activities were associated with gender-balanced retention. For example, when faculty members simply encouraged their students to persist in a CS major, there was a measurable positive effect on undergraduate women's retention. Unfortunately, as with mentoring for diversity, fewer than half the faculty in the average department reported that they encouraged persistence (Cohoon, 2006).

The observation about the value of encouragement from faculty helps illustrate how seemingly minor elements of faculty-student communication can produce measurable differences in outcomes. Simply encouraging students to persist can promote women's retention, but defensive communication behaviors promote women's lower confidence and attrition from computing (Garvin-Doxas & Barker, 2004). According to this research, when faculty members create a supportive communication climate in their courses, CS is more inclusive of women.

Homework is another way that faculty members can have a positive influence on women's retention. Departments where faculty members expected nine hours of homework per week for one course were more likely to retain women at high rates than departments where less homework time was expected (Cohoon, 2006). This instructor emphasis on practice as a route to mastery of the subject matter helps women persist at rates similar to their male classmates.

Belief that successful students limit their extra-curricular involvement is a faculty attitude associated with gender-balanced enrollments. Faculty understanding of the effort required to master the subject matter helps female students succeed. As one faculty member put it in an interview following up on a study of undergraduate computing, "Everyone can get this stuff, but some have to devote more time" (Cohoon, 2006). Similarly, according to Margolis and Fisher (2001), the view that computing is a skill that can be learned if students apply themselves is common to women who persist in undergraduate CS. When their instructors endorse the same view, women are retained at rates approaching their male classmates' retention rates.

Finally, the pedagogical approach employed by faculty can work to retain more women in computing. When faculty members create a collaborative learning environment in the form of pair programming, students get support from peers, and all students benefit. The result for women is higher retention rates (Berenson, Slaten, Williams, & Ho, 2004; Werner, Hanks, & McDowell, 2004).

The evidence is strong that faculty can help retain women in CS. Mentoring for diversity, encouraging persistence, emphasizing homework and academic focus, and creating collaborative learning environments are all ways that faculty members can help prevent women's disproportionate departure from the major.

Advancing and Recruiting Women into Graduate School in Computer Science

Faculty can advance their students to graduate study in computing by mentoring (Cohoon et al., 2004). More than three quarters of faculty members say that they encourage their undergraduates to go to graduate school. But, this action is insufficient for influencing students. Mentoring activities such as helping students learn to conduct research and publish papers are what measurably increase the percent of students who advance directly to graduate school (Cohoon et al., 2004). We have not yet determined whether this effect applies equally to women and men.

Effective recruiting methods are less well-documented than retention methods. The Computing Research Association's 2001 best practices report, "Recruitment and Retention of Women Graduate Students in Computer Science and Engineering," listed 20 expert-endorsed methods (Cuny & Aspray, 2001). Empirical tests have yet to show that these recommendations are effective.

In 2003, we conducted surveys of faculty and students in 48 graduate programs in CSE nationwide (Cohoon & Lord, 2006). Data from this study show that faculty members believe meeting with potential students and encouraging them to enroll is the best way for increasing the number of women graduate students in their program. Our data suggest they are correct that personal contact can be an effective recruiting strategy, but it is seldom employed to promote women's enrollment.

FUTURE TRENDS

There are a number of significant questions that must be answered. Most importantly, we need to learn what leads more faculty members to engage in the behaviors that promote women's entry and persistence in postsecondary computing. In addition, more research and analysis of existing data are needed to identify effective methods for recruiting women.

CONCLUSION

Despite the many factors beyond the control of postsecondary computing departments, there is solid evidence that faculty behaviors can contribute to gender balance. Both the research on women in STEM and research on women in computing provide evidence that faculty members can promote and maintain women's participation.

NOTE

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KEY TERMS

Attrition: Switching to a different major after having declared a computing major.

Computer Science: General computer and information sciences; computer programming; data processing technology; information science and systems; computer systems analysis; and other information sciences.

Gendered Attrition Rate: Result of subtracting the female attrition rate from the male attrition rate to obtain a single measure of the gender gap in attrition rates.

Mentor: Faculty member who may advocate for a student, offer social and emotional support, and provide useful information about how to perform within a university program.

Recruitment: Actively attracting students to declare a major.

Retention: Continued enrollment in a major until graduation.

Role Model: A person who serves as an example of the values, attitudes, and behaviors associated with a role.

Female Perceptions of the Information Technology Culture

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INTRODUCTION

In the organizational sciences literature, one of the important social forces that affect the productivity, adjustment, attitudes, and retention of employees is culture. Culture can be defined as the shared philosophies, ideologies, values, assumptions, beliefs, expectations, attitudes, and norms that people have in common with others in a community (Hall, 1959, 1976; Hofstede, 1997; Trice, 1993). Cultures originate as individuals interact with one another. Belonging to a culture involves believing what others believe and doing as they do (Trice & Beyer, 1993). The most obvious manifestations of culture are common language and common ways of thinking (Schein, 1999).

These common ways of thinking are also evident within organizations as employees share basic assumptions on how to do things and solve problems in a way that is considered valid by organization members and, therefore can be taught to new members as the correct way to perceive, think, and feel in relation to those problems (Schein, 1992).

Because culture within organizations is multifaceted, it includes both: the overall culture of the organization as well as subcultures shaped by the specific kind of work that people do in the organization. In contrast to organizational cultures, occupational subcultures arise from the shared educational, personal, and work experiences of individuals who pursue the same kind of work or occupation (Trice, 1993; Trice & Beyer, 1993).

The purpose of this chapter is to present a comprehensive summary of previous studies relating to the concept of occupational subculture of information technologists and the perceptions and difficulties that female students illustrate during their first approaches to the IT occupation. We believe that understanding the difficulties that women face to accommodate to the IT culture can better help academic institutions and industry practitioners develop customized strategies for retention and recruitment of women in the IT field.

BACKGROUND

Occupational cultures have the same characteristics as any culture with a different degree of distinctiveness based on the occupation. Studying cultural characteristics allows managers and academics to develop better human resource strategies that will affect favorable productivity, adjustment, attitudes, and retention of employees in organizations. As stated by Trice (1993) occupational subcultures consist of distinctive clusters of ideologies, beliefs, cultural forms, and other practices that grow uniquely in the context of a particular occupation. Table 1 summarizes the characteristics of an occupational culture based on Trice's theory (Trice, 1993).

THE OCCUPATIONAL CULTURE OF INFORMATION TECHNOLOGISTS

The role of information technology (IT) workers is critical in the development, acquisition, management, use, support, and maintenance of information

Table 1. Summary of the characteristics of an occupational culture

Characteristic	Description
Collective	Cultures are collective, they originate as individuals interact with one another. Cultures are repositories of what their members agree about believing and doing. Belonging to a culture involves believing what others believe and doing as they do.
Emotionally charged	Substance and forms are infused with irrational feelings and elaborate rationales for them. These emotions are propagated through socially accepted channels.
Historically based	Cultures emerge over time but are based on a unique history. The interaction of a particular group in a unique set of physical, social, political, and economic circumstances develops ideologies and forms that are later shared with other individuals who practice those ideologies over time.
Inherently symbolic	Cultures emphasize the expressive side of human behavior. Symbols are the basic unit of cultural expression. Symbols are present everywhere in social life. They can be practically any object, word, act, emblem, dress, etiquette, etc.
Dynamic	Cultures create continuity and persist across generations of members but they are not static. Cultures change constantly. Some of the reasons are the imperfect communication and understanding over time, the individual influences of new members, unconscious transmission, multiple meanings of the symbols of the culture, and the influence from outside.
Inherently fuzzy	Cultures combine contradictions, ambiguities, paradoxes, and confusion. They are also characterized by "enormous multiplicity."
Encourage ethnocentrism	A collectivity may come to be very emotionally attached to a set of ideologies. As a consequence, its culture will be strengthened and the collectivity will come to distrust, fear, and dislike groups with other sets of beliefs. The more emotionally charged these ideas are, the more likely adherents are to be intolerant of those with divergent ideas.
Dysfunctional as well as functional	Strongly held ideologies add to the cohesion among members of an occupation, but at the same time, they make for a rigidity and bitterness toward outside groups, often blocking needed cooperation.
Structure social relations	Cultures, guided by their ideologies, tend to produce mechanisms that arrange the relationship between their members, namely the structure of social relations.

Source: Trice, 1993

technologies and systems. This group of workers with IT skills and knowledge base continually acquired from a variety of formal and informal sources in several specialties, compromise an occupation that crosses and transcends organizations and has its own characteristics. In the 1990s, Duliba and Baroudi (1991) conducted an empirical study in order to identify if the occupational culture of IT workers exists or not. In their study, they concluded that IT personnel indeed form an occupational culture (Duliba & Baroudi, 1991) but back then, this culture did not manifest strong values and cultural forms and instead IT workers formed a weak occupational culture. Because the IT occupation has developed and grown more in the last decade socially and within organizations, recent studies can now better identify the ideologies, beliefs, cultural forms, and other practices that define this community. In other words, we can now identify the features of the occupational culture of information technology workers.

Having that purpose in mind, researchers have recently conducted empirical studies looking for the ideologies, beliefs, cultural forms, and other practices that IT workers manifest (Gerulat, 2002; Guzman & Stanton, 2004; Guzman et al., 2004). Table 2 summarizes the features of the occupational culture of IT workers.

Individuals who are part of the occupation first come into it with values derived from family, school, and community. As they evolve in their occupational communities, individuals go through a process of adaptation where they manifest positive and negative reactions of adjustment to the culture. We were interested in those reactions, particularly the reactions of female individuals who are currently going through a process of occupational socialization in the information technology field. Occupational socialization is the process by which individuals acquire, learn, and adopt the ideologies, beliefs, cultural forms, and practices of an occupational culture. Because the process of occupational socialization begins while individuals are pursuing an academic major, the participants of this study were students of IT related majors who are learning and adopting the ideologies, beliefs, cultural forms, and practices of the IT occupational culture.

Table 2. A Summary of the features of the IT occupational culture

Cultural Characteristics of the IT Occupation
1. The IT culture is elitist, valuing technical knowledge and skill above other values
2. The IT culture is exclusionary because it excludes from membership those individuals who do not possess a sufficiently high level of technical knowledge and skill ranging from the ability to mange IT resources to using IT resources
3. The IT culture views technical knowledge and skill as essential to achieve its informal mission of delivering stable, high-quality computer systems to organizations
4. Normative behavior for this group includes the constant acquisition of technical knowledge and skill in an effort to deliver quality and stable computer systems to the organizations that employ the individual members
5. IT workers frequently use technical knowledge, jargon, and vocabulary as a means of establishing group identity, maintaining boundaries between groups, and excluding out-group members
6. There are extreme and unusual demands pertaining to working in the profession, particularly relating to long hours, angry users, and the need for constant self re-education
7. People in this culture complain about the behaviors and abilities of end-users and about being misunderstood by managers as a form of intra-group bonding
8. A shared sense of satisfaction about helping others with technology that supports and justifies the importance of the occupation is usually present
9. Professional ethnocentrism including feelings of superiority and control over the technology when they solve IT problems
10. Physical settings involving electronic equipment and disorder as signals of group membership
11. Unique and shared stories about the history of information technology as a means of identifying members, validating membership and as a form of intra-group bonding
12. Lack of formal work rules and absence of clear requirements for membership

WOMEN'S PERCEPTIONS ABOUT THE IT OCCUPATIONAL SUBCULTURE

To enhance our understanding of women's perceptions about the IT occupational subculture during the process of occupational socialization, we conducted six focus groups in order to investigate the interaction between female participants and other individuals where they discussed their individual perceptions about the IT occupational culture. Using focus groups as a data elicitation technique there is potential within the group interaction for power relationships to be more greatly diffused, for knowledge to be collectively constructed, and for empowerment, as participants challenge, question, critique and learn from each other (Morgan, 1997; Pini, 2002).

We recruited a total of 46 college students taking IT classes with whom we conducted six focus groups during a period of three months. Focus groups discussions lasted an average of 55 minutes. One of the focus groups was specifically organized to elicit women's perceptions therefore, only women participated. This group had a total of nine women and the moderator was a woman as well.

Our data analysis focused mainly on the responses provided by women. Women's answers were analyzed from the group-grid dimensions' perspective. According to Trice (1993) the group and grid dimensions developed by Douglas (Douglas, 1978) are useful for examining sub cultural relationships because they link culture and behavior in a way that can be observed and determined. "The group dimension consists of the emotionally charged beliefs that organize and maintain ideologies about how to create meaning and control in work life; the grid dimension consists of the tangible structures through which members of an occupation attempt to order their relations with one another" (Trice, 1993).

Based on the group-grid dimensions we found conflictive women's perceptions regarding the IT occupational subculture that we present in the selected most representative excerpts below.

Female IT students do not necessarily view technical knowledge and skills as the most essential value in their occupation. Instead, women value first social instances and interaction with people:

I'm more of a people person rather than just IT.

I want to be an IT professional but I also want to be sociable.

Because of differing primary values, women IT students often get into the IT field based on an extrinsic reward such as diverse application of IT skills or the quick opportunity to get a job due to the high demand. Women IT students also often enter the field in order to comply with other's expectations (i.e., parents) or because they think that having IT skills is a good 'complement' to another more relevant set of skills.

The world is so technological, like everything right now is all about that. Like any job you do has a technology aspect of it.

IT knowledge applies to whatever function of a company or organization.

I'm just doing it because I think it'll benefit me but I don't like it.

I think of it more as a way to advance whatever position you want to do. Like you find a position that makes you happy and use IT as a tool to get to the top. It's something extra that you have in your background over other people that you can use to advance your career.

I was one of the only three girls in the orientation and the other two girls weren't interested. It was obvious their parents were just forcing them into it.

Another aspect about the occupational culture is the physical setting and symbolic representations of the occupation that are negatively described by female IT students. Our participants showed that they relate the occupation as a job where a person is always sitting in a cubicle in front of a computer, and that perception is usually negatively seen:

I do not see myself sitting in front of a computer all day long.

My mom does it [she is an IT person] and immediately things that come to mind are a cubicles and office space where they type away at the screen all day.

Finally, the fact that women are under represented in the IT field generates different kinds of reactions, but women are definitely aware of that. As they mention, this could be taken in their advantage but sometimes it is uncomfortable:

We women in IT are oddballs.

The IT people at my father's office didn't think there were women in the field.

I like being the only girl ... it shows you how the real world is going to be.

FUTURE TRENDS

Given the high demand of information technologists in all types of organizations in the United States and the underrepresentation of women in the IT field, it is important to understand the culture of this occupation in order to customize recruitment and retention strategies for women. We observe that there are some divergences between women's expectations, beliefs, and values that do not correspond to the features of the occupational culture of the IT occupation. Having a better understanding of the culture of the profession as well as the main beliefs and values of women with similar studies like the one presented in this chapter will give academic institutions and industry practitioners better insights into the development of training programs. Since our participants were college students in IT majors, it could be interesting to develop studies that would also identify perceptions of women who have been working in the IT field for several years and see how those perceptions differ from those belonging to participants in our study.

CONCLUSION

It is imperative to know more about the specifics that characterize the IT occupation. Most of the better-known cultural forms in society are negative. Having a clear understanding of all the cultural forms of the IT occupation would allow people to know about the diversity of ideas and activities involved in the profession and reduce conflictive perceptions regarding the IT occupational subculture.

As individuals evolve in their occupational communities, they go through a process of adaptation where they manifest positive and negative reactions to the adjustment of culture. We were interested in those reactions, particularly the reactions of female individuals who are currently going through a process of occupational socialization in the information technology field. Because this process of occupational socialization begins while individuals are pursuing an academic major, the participants of this study were students in IT related majors. However, since data was collected from a small number of individuals, data presented in this chapter should not be interpreted as generally applicable to all women in the IT field. Rather, these results can be viewed as suggestive of the possible explanatory power of the differences of women's perceptions and the cultural values of the IT occupation.

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KEY TERMS

Group and Grid Dimensions: These dimensions link culture and behavior in a way that behaviors of people can be observed and determined The group dimension consists of the emotionally charged beliefs that organize and maintain ideologies about how to create meaning and control in work life; the grid dimension consists of the tangible structures through which members of an occupation attempt to order their relations with one another.

Information Technology Job: A predetermined set of activities one is expected to perform within the information technology field.

Information Technology Occupation: A coherent set of jobs that are similar with respect to the type of tasks and training involved related to the development, acquisition, management, use, support, and maintenance of information technologies and systems.

Occupational Community: the group of people with their own occupational culture

Occupational Culture: This term is used referring to an influential occupational subculture outside the organizational context.

Occupational Socialization: The process by which individuals acquire, learn, and adopt the ideologies, beliefs, cultural forms, and practices of an occupational culture. Through this process, individuals learn what is OK and what is not OK to tell and do in a variety of situations related to their occupations (Schein, 2004). This process comprises five overlapping steps: attraction, access, adjustment, identification, and commitment. Occupational socialization is complete when an individual internalizes the value and norms of the occupational group.

Occupational Subculture: The basic assumptions, cultural forms, ideologies, and behaviors that grow uniquely in the context of a particular occupation. An occupational subculture arises from the shared educational, personal, and work experiences of individuals who pursue the same profession and share similar ideologies and forms of expressing those them in speech and behavior.

ENDNOTE

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Female Pupils' Perception of Electrical Engineering

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INTRODUCTION

Recent studies have focused on gender issues and women's underrepresentation in fields such as computer science, software engineering (Camp, 1997, 2002), and information technology (Varma, 2003). This article broadens the discussion to include the field of electrical engineering (EE), in which the underrepresentation of women is even more salient than in the aforementioned fields. For example, the percentage of female undergraduate students in the Department of Electrical Engineering at the Technion – Israel Institute of Technology (IIT), Israel's leading school of engineering, is less than 15%.

Although there are no easy solutions to the complex problem of attracting women to the field of EE, we argue that certain measures can nevertheless have an impact. Specifically, a partial solution might be to increase the awareness of female high-school pupils, first, to the very existence of the field of EE, and second, to its diverse nature. This article reports on an annual exposure day that aims to do just that. This event, entitled "Electricity in the Palms of Her Hands," specifically targets female high-school pupils who excel in mathematics. This exposure day, the title of which follows the words of a popular Hebrew song, gives the pupils a glimpse of the variety of subfields EE encompasses, and thus gives them a very different perspective on EE as well as a different image of the professionals working in the field.

Specifically, the article examines the perception of EE as expressed by high-school female pupils on two such exposure days. We focus on one main observation: the change the exposure day induces on the pupils' perception of the profession of EE. Our study shows that, whereas in the morning of the exposure days, the pupils perceived EE to be a technical field and did not consider it as a major field of study, by the end of the days, the pupils were describing its multifaceted nature, and many of them perceived EE to be a profession that they might consider studying.

BACKGROUND

The Department of Electrical Engineering at Technion[1]

The Department of Electrical Engineering at the Technion is ranked among the top-10 electrical engineering and computer science departments in the world. It is the largest of Technion's departments, with 1,800 undergraduate students in four main study programs (electrical engineering, computer engineering, computer and software engineering, and electrical engineering and physics), and over 400 graduate students. The department is a center of excellence in both applied and theoretical research. Over 10,000 of the department's graduates hold leading positions in the Israeli hi-tech industries, and they comprise 70% of the chief executive officers and vice presidents of development and engineering in Israel.

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Women in Technion's Department of Electrical Engineering

The percentage of women studying EE at the Technion is relatively low. In 2002, only 12.3% of the department's undergraduates were women, and that ratio increased only slightly in 2003 to 13% and in 2004 to 14%. The existence of associations in several of the leading universities that aim to provide community, mentoring, and enrichment for graduate women students in EE reveals that a similar phenomenon exists in other universities as well (see, for example, the Women in Electrical Engineering [WEE] organization at Stanford—http://wee.stanford.edu/index.php).

At the same time, achievements of the female EE students are, on average, high. According to Professor Baruch Fischer, former dean of the department (1999-2003), women are equally capable of succeeding in EE studies as are men. "The low representation of women in the department results from the low awareness of what the department offers and what its research areas are, as well as the unjustified 'masculine' image of the profession of EE," said Professor Fisher in the *Technion Magazine* of winter 2004.

In the past 4 years, an attempt is being made to increase the representation of women in the Department of EE's undergraduate programs. The department decided to expose female high-school pupils to the richness and variety of subjects currently studied at the department, to its distinguished research laboratories, to career opportunities in EE, and to pros and cons of being a female electrical engineer. This decision materialized in the form of an annual exposure day entitled "Electricity in the Palms of Her Hands." During the past 4 years, about 400 female high-school pupils, from an array of Israeli high schools, attended these exposure days. During these days, the pupils heard lectures, saw demonstrations, visited laboratories, and met with female graduate and undergraduate students of the department.

The Exposure-Day Format

Table 1 describes the exposure day's agenda. Dr. Ayellet Tal, the second author of this article, formally opens the event. Dr. Tal is a female faculty member of the Department of EE and head of the exposure day's organizing committee. After the dean's greetings, a female undergraduate student describes her experience as a student at the Department of EE. The pupils then listen to a plenary talk on the interrelations among science, technology, engineering, and society. This plenary session increases the pupils' awareness of the facts that (a) women can succeed in EE, and (b) women are still underrepresented in the field of EE.

Table 1. Exposure-day agenda

Hour	Topic
9:00-9:30	**Opening:** Dr. Ayellet Tal, an EE female faculty member, describes her research on computer graphics. Dean gives words of greeting. An undergraduate student describes her social and academic life in the department.
9:30-10:00	**Plenary talk:** Engineering and society
10:00-12:00	**Parallel activities:** Demonstrations and visits to the department's laboratories
12:00-12:30	Lunch break
12:30-13:30	A tour of the Technion campus
13:30-14:15	**Parallel activities:** Meetings with female alumni of the department
14:15-14:30	**Closing session**

The exposure day then proceeds with two sessions of parallel activities conducted in small groups. During the first session, groups of about 20 pupils each visit several of the department's laboratories, hear talks, and see experiments. Each pupil is directed to activities and laboratories related to topics that are close to her own fields of interest.

After a lunch break, each small group of female high-school pupils meets a female alumnus of the EE department. These women alumni represent a wide range of areas in which an electrical engineer can develop a career following graduation. The objective of the meetings is to increase the pupils' familiarity with the actual work of electrical engineers in general, and to expose them to the personal stories of female electrical engineers in particular.

The main ideas emphasized throughout the exposure day are the following:

- **The Interdisciplinary, Multifaceted Nature of the Profession of EE and the Variety of Topics that it Encompasses:** In order to change the vague public image of EE, the exposure day deals with a variety of topics (microelectronics, artificial intelligence, image processing, connections to biology, computer graphics, etc.).

- **The Close Relationship Between EE and Society and Real-Life Applications:** Research reveals that "women, to a somewhat greater extent than men, are apt to choose fields of study they believe will contribute to the social good, and engineering and related sciences are not widely perceived as professions making such contributions" (Muller, 2003, p. 121). Accordingly, women might not choose an EE career if their perception of the field does not include social aspects. For this reason, the exposure day emphasizes applications and products developed by electrical engineers that directly affect everyday life, culture, and art, such as state-of-the-art technologies for picture and music processing.
- **Women's Representation:** The percentage of women who play an active role in the conference is much higher than their overall representation in the department. In addition, these women are from different backgrounds and hold various degrees and positions: faculty members, graduate students, undergraduate students, and alumni. The assumption is that this close interaction with female electrical engineers from different backgrounds has the potential to influence the pupils' perception of the professional lives of electrical engineers.
- **Students' Cultural and Social Lives:** Although learning and professional development are the main goals of students who choose to study at the Department of EE, the cultural, social, and communal aspects of student life cannot be ignored since they may influence the pupils' future choice whether or not to study in a specific department. To illustrate some of the social aspects of life in the Department of EE, the exposure day is held on a day of the week on which the students' arts and crafts fair takes place. As can be seen in Table 1, the conference schedule includes a tour of Technion, which allows for free time to visit the fair, listen to the music, taste the Technion atmosphere, and talk with current students.

MAIN THRUST OF THE ARTICLE

The study described in this article was guided by two main objectives. First, we wished to reveal the pupils' perception of EE. Second, we wished to evaluate how the exposure days can impact this perception. In order to accomplish these goals, we used open questionnaires and ethnographic observations. The questionnaires are presented in Hazzan, Levy, and Tal (2005).

From a comparison of the pupils' written responses given at the end of the day with those given in the morning, it is clear that a change took place during the day and that the pupils reconstructed their perception of EE. As is illustrated in what follows, while in the morning the pupils' preconception of the profession of EE indicated ignorance and a lack of awareness to what EE is, the end-of-the-day perception was focused and addressed the multifaceted nature of the field.

Tables 2 and 3 illustrate the change of perception seen in the questionnaires at the 2003 conference. As Table 2 indicates, only one third of the pupils expressed any meaningful perception of EE in the morning, whereas the other two thirds had either no meaningful answer to give or gave answers that reflected ignorance and lack of awareness. In contrast, when asked again at the end of the day, most of the pupils' answers indicate that during the day they had constructed an academic, engineering, scientific, and human-related image of the profession. Furthermore, at the end of the day, terms that indicate a multifaceted perception of EE were used to describe the profession of EE (e.g., *variety*, *combination*, *broad*, *no limits*).

More specifically, as Table 2 shows, the pupils' perception of EE underwent transformation over the course of the day with respect to three categories. First, the multifaceted nature of the field, barely mentioned in the morning, was mentioned frequently in the pupils' answers at the end of the day. Second, the technical (instrumental) aspect, which was so prominent in the morning, all but disappeared throughout the day. Third, the social aspect, which was not mentioned at all in the morning, emerged at the end of the day. The emergence of the last category is important since, as mentioned earlier, women tend to choose human-related professions.[2]

Table 2. Perception of EE before and after the 2003 exposure day

	Before the exposure day	After the exposure day
Question	No. 5: What do you think EE graduates do when they graduate from Technion?	No. 2: What would you say if you were asked to explain what EE is in two sentences?
Total number of answers	120	45
Number of meaningful answers (%)	44 (36%)	40 (89%)
Elaboration on the meaningful answers	Only two answers addressed the multifaceted nature of EE, e.g., "A combination of several branches that are involved in the invention of instruments in different domains (such as medicine)."	21 answers (50%) described EE as a multifaceted field, e.g., "A huge variety of similar, as well as different, domains that are connected to the society, economy, industry, and to our life in general."
	7 pupils mentioned computers.	18 pupils mentioned computers.
	18 pupils presented the profession of EE as a technical profession, addressing tools and instruments.	3 pupils indicated tools and instruments.
	4 of the above 18 pupils indicated the electricity company, e.g., "They go to work in companies like the electricity company," and "Maybe they go and work as technicians in areas that are related to electricity, etc."	4 pupils specifically indicated that EE is not the electricity company, e.g., "Now I know that it does not mean only working in the electricity company."
	None of the pupils indicated any connection to society or to any other social issues.	5 pupils indicated social issues, e.g., "A kind of engineering that is manifested in electrical products and contributes to the quality of life."
Number of non meaningful answers (%)	76 (64%)	5 (11%)
Examples of meaningless answers	"Engineering electricity," and "Look for a job in companies in which electrical engineering can work."	"I can't explain it in two sentences." *

*Note: *This answer might also be interpreted as a reflection of the idea that EE is too rich to be described in two sentences.*

Table 3. Activities performed by electrical engineers: Pupils' perception before and after the exposure day

	Before the exposure day	After the exposure day
Question	No. 5: What do you think EE graduates do when they graduate from Technion?	No. 3: List at least three things that people who work in EE do when they graduate from Technion.*
Number of answers	120	39
Areas in which electrical engineers work	10 general areas were mentioned, such as research and development (19 pupils), and hi-tech (18 students, e.g., "Work in hi-tech companies").	20 areas were mentioned; 11 of them were specific areas presented during the exposure day (e.g., robotics, image processing, artificial intelligence).
Indication of specific topics	Only 4 pupils indicated a specific topic such as robotics.	37 out of a total of 84 items mentioned were specific domains to which the pupils were exposed during the day.
Teaching	2 pupils mentioned teaching (e.g., "Work as teachers or in companies for engineering of electricity").	9 pupils indicated "academic teaching."
Technical image	18 pupils mentioned instruments and/or the electricity company (e.g., "Build electrical circuits for instruments," and "Engineering machines, prepare the electrical systems in buildings, etc.").	No technical or tool-oriented answers were given. Only 1 pupil mentioned the electricity company.

*Note: *It may be the case that had the pupils been asked also in the morning to mention three items, their morning answers would be more focused. Still, these answers would probably be general in nature.*

Table 4. Possible future studies at Technion's Department of EE

Would you consider studying at Technion's EE Department?	2003		2004	
	Morning (N=124)	End of the day (N=44)	Morning (N=86)	End of the day (N=56)
Yes	19 (15%)	29 (66%)	22 (26%)	46 (82%)
No	50 (40%)	11 (25%)	28 (33%)	7 (13%)
Maybe	52 (42%)	4 (9%)	33 (38%)	3 (5%)
N/A	3 (2%)		3 (3%)	

Table 3, which addresses typical activities associated by the pupils to electrical engineers, adds another dimension to this process of perception changing. More specifically, while in the morning pupils' descriptions tended to be vague and general, much more specific and concrete descriptions were exhibited at the end of the day. Furthermore, Table 3 reveals that on the afternoon questionnaire, a greater proportion of pupils mentioned a wider variety of specific areas in which electrical engineers work compared with the morning questionnaire, and that the predominantly technical image of EE was transformed over the course of the exposure day. Moreover, from among the 20 domains mentioned by pupils in their afternoon answers, 13 were mentioned by more than one pupil. The most frequently mentioned domains were software and hi-tech (appeared in 23 answers, 16 of which mentioned the names of well-known companies, such as Intel and IBM); research (10 answers); and academic teaching, robotics, and electronics (9 answers each).[3] Similar observations were found in the 2004 conference (Hazzan, Tal, & Keidar, in press).

This image change may explain the reduction in pupils' resistance toward the idea of studying EE as a major field of study, as presented in Table 4. In both the 2003 and the 2004 conferences, a considerable increase in students' interest in the department was observed. Specifically, this interest increased during the 2003 conference from 15% in the morning to 66% by the end of the day; during the 2004 conference, interest increased from 26% to 82% (Table 4).

FUTURE TRENDS

In order to study the long-term influence of such exposure days, we plan to examine the way in which the female high-school pupils who attended the exposure days will perceive EE at several future points in time. Such an exploration will help refine observations and recommendations about the preferred way in which the profession of EE should be presented to a female audience that is not familiar with the nature of the profession.

CONCLUSION

The aim of the study described in this article was to examine the perception of EE by female high-school pupils at the beginning and at the end of an exposure day organized by the Technion's Department of EE. The rationale for the day stemmed from the very salient underrepresentation of women among the undergraduate students and graduate students in the department.

We derive two major conclusions from this study with respect to the way in which the profession of EE may be presented when the objective is to attract more women to the field.

First, as in the case of computer science, the profession of EE seems to suffer from a misconceived image among the public. In the case of computer science, many people think that to be a computer scientist means sitting in front of a computer screen all day long, without communicating or socializing with other people (Margolis & Fisher, 2002). In the case of EE, from the pupils' responses at the beginning of the day, we learn that their image of EE was very technical and that they were unaware of the social, scientific, and multifaceted nature of the field. The exposure day described in this article shows that this image can be changed in a relatively short period of time, provided such a day is well organized so as to include the relevant ingredients that inspire a more realistic image of the profession. Specifically, we argue that emphasis should be placed on the multidisciplinary nature of the field in general, and on the direct influence of this trait on society in particular.

Second, we suggest exposing the pupils attending such a day to female role models. Such exposure enriches the image of the profession by adding the individual perspective of the profession to the more global perspective that was explained in the previous paragraph.

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KEY TERMS

Artificial Intelligence: The field concerned with making computers behave like humans. The term was coined in 1956 by John McCarthy at the Massachusetts Institute of Technology.

Computer Engineering: The application of engineering principles and methods to the design and development of hardware systems. (http://www.hpcc.gov/pubs/blue94/section.6.html)

Electrical Engineering: Electrical engineering is one of the broadest of the engineering disciplines. It deals with electronics, computers, and communication. The professional activities of electrical engineers directly affect the everyday lives of most of the world's population.

Image Processing: The field concerned with analyzing and manipulating images with a computer.

Multimedia: The use of computers to present text, graphics, video, animation, and sound in an integrated way.

Robotics: The field concerned with creating robots: devices that can move and react to sensory input. Robotics is one branch of artificial intelligence.

Shrinking Pipeline: The pipeline represents the ratio of women involved in computer science from high school to graduate school. The pipeline shrinkage problem focuses on several exit junctions: from high school to undergraduate school, at the bachelor's level, and at the seniority levels both in academia and the industry.

Software Engineering: The application of engineering principles to software. It applies principles of computer science and mathematics for the development, operation, and maintenance of software. Software engineering addresses not only the technical aspects of building software systems, but also social, management, and cognitive topics.

ENDNOTES

1 For additional details, visit the department's Web site at http://www.ee.technion.ac.il/.

2 The drop in the number of responses between the survey at the beginning of the exposure day and the responses after the exposure day is due to the fact that the transportation organized by several schools had left before the day ended.

3 In addition, lasers was mentioned six times; image processing, computerized graphics, or animations was mentioned five times; and information processing, film dubbing, and machines were each mentioned three times. The following domains were mentioned only once: multimedia, biomedicine, artificial intelligence, the electricity company, cellular-phones companies, and job seeking.

Female Retention in Post-Secondary IT Education

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INTRODUCTION

The historical gender stratification in technical disciplines has been an area of study for many years and researchers have concluded that women are alarmingly under-enrolled in post-secondary information technology (IT) education (e.g., Camp, 1997; Teague, 2002; von Hellens, Nielsen, Greenhill, & Pringle, 1997). One challenge facing the IT gender gap discourse is the application of theories that focus on a variety of levels of analysis (Korpela, Mursu, & Soriyan, 2001; Walsham, 2000). Recently, the Individual Differences Theory of Gender and IT has been proposed by Trauth (Trauth, 2002; Trauth, Huang, Morgan, Quesenberry, & Yeo, 2006; Trauth & Quesenberry, 2006, 2005; Trauth, Quesenberry, & Morgan, 2004) to explain the underrepresentation of women in the IT workforce at both the societal *and* individual levels of analysis. To date, the majority of the Individual Differences Theory of Gender and IT research has focused on improving our understanding of the underrepresentation of women in the IT workforce.[1] Hence, in an attempt to build on the theoretical foundation, this article reports on a literature survey of the influences on American women's retention in post-secondary IT education.

BACKGROUND

Walsham (2000) stresses the importance of research agendas that help to improve the understanding of IT in the contemporary world. Hence, researchers should investigate IT that enables connectivity, but supports diversity by studying particular levels of analysis in detail and context including: the individual, group, organization, inter-organization, and society levels. Korpela et. al. (2001) also support the level of analysis concept by constructing a 2x4 + History framework, which contains four integrative levels of analysis: the individual, group/activity, organizational, and societal levels.

The Individual Differences Theory of Gender and IT articulated by Trauth (Trauth, 2002; Trauth & Quesenberry, 2006, 2005; Trauth et al., 2004, 2006) answers the call for research at multiple levels of analysis stressed by Walsham (2000) and Korpela et al. (2001). First, the theory focuses on women as individuals, having distinct personalities, experiencing a range of socio-cultural influences, and thus exhibiting a range of responses to the social construction of IT. As a result, the theory focuses on an individual level of analysis while acknowledging gender group and societal influences. Secondly, the Individual Differences Theory of Gender and IT takes into account the role of gender group and societal shaping and the importance of individual critical life events (Trauth, 2002; Trauth & Quesenberry, 2005, 2006; Trauth et al., 2004, 2005a).

This theory accounts for the differences among women in the ways they experience and respond to the IT workforce using three constructs: personal data, shaping, and influencing factors and environmental context (Trauth et al., 2004). The personal data construct includes: demographic data (e.g., age, race, and ethnicity), lifestyle data (e.g., socio-economic class and parenting status), and workplace data (e.g., job title and technical level). The shaping and influencing factors construct includes: personal characteristics (e.g., educational background, personality traits, and abilities), and personal influences (e.g., mentors, role models, experiences with computing, and other significant life experiences). The environmental context construct includes: cultural attitudes and values (e.g., attitudes about IT and/or women), geographic data (about the location of work), and economic and policy data (about the region in which a woman works).

MAIN THRUST OF THE ARTICLE

A literature survey of gender and IT research was conducted to understand how individual attributes contribute to the retention of females in post-secondary IT education in support of the Individual Differences Theory of Gender and IT (Trauth, 2002; Trauth & Quesenberry, 2005, 2006; Trauth et al., 2004, 2006). This analysis resulted in the identification of several research themes that influence women in IT education. These themes include: personal attributes, learning experiences, and responses to support structures and will be discussed in more detail in the remainder of this section.

Personal Attributes of Students

Researchers have found that self-confidence has a large influence on female retention in post-secondary education (Alper, 1993; Ambrose, Lazarus & Nair, 1998; Beckwith, Burnett, Wiedenbeck, Cook, Sorte, & Hastings, 2005; Vest & Kemp, 1999). Shashaani (1994) argues that there is a direct connection between informal computing experiences and high levels of self-confidence in using and understanding IT. This notion is articulated by Margolis and Fisher (2002) in their argument that men tend to have more informal computing experiences than women at the post-secondary level. As a result, male students generally have higher levels of computing self-confidence than female students. Over time, this causes female students to question their technical knowledge and personal fit with an IT related degree, eventually leading to lower female retention numbers.

Research has also demonstrated that negative images of the IT workforce have an influence on the retention of women in post-secondary IT education (Ahuja, Robinson, Herring, & Ogan, 2004; Balcita, Carver & Soffa, 2002; Camp, 1997; Nielsen, von Hellens & Wong, 2000; Vest & Kemp, 1999). Joshi, Schmidt, and Kuhn (2003) and Camp (1997) explain that both men and women acknowledge the negative stereotypes of IT work (e.g., IT work is solitary and a male domain). Furthermore, these stereotypes persist despite receiving accurate information about IT careers (Joshi et al., 2003). Balcita et al. (2002) argues that these negative stereotypes are shaped by the media, and society, which frequently present the IT domain as a place that does not welcome feminine characteristics or traits. For instance, television shows such as *Bill Nye the Science Guy* and *Mr. Wizard* demonstrate strong male presence in science, but lack female role models with whom women can identify. As a result, women, more than men, leave post-secondary IT education programs because they cannot imagine their roles within the field.

Student Learning Experiences

Barker, Garvin-Doxas, and Jackson (2002) and Katz, Aronis, Allbritton, Wilson, and Soffa (2003) argue that experiences in learning environments also have an influence (positive and negative) on female retention in post-secondary IT education.[2] These authors found that the influences of impersonal environment and guarded behavior, informal student hierarchy, and the creation of a defensive social climate are the most important factors in student retention. For instance, Barker et al. (2002) observed that technical courses in post-secondary IT education have the tendency to be impersonal social environments in which it is easy for students to remain relatively anonymous and socially distant. The authors found that it was rare to hear the names of students or the sharing of personal information among students and professors in technical classes. Students in these technical courses were typically referred to as “the woman in the red shirt” or by desk location such as “F1.” In addition, informal hierarchies were created by the attainment and display of status in social structure of the classroom. In these technical courses, status was afforded to those students who displayed the highest level of technical skills. Students with programming experience were frequently referred to as “smart” and it was implied that they had intellectual superiority over the other students. Eventually, students became aware of whether they belonged in the group and their places in the social hierarchy. Unfortunately, the female students felt as outsiders and did not share social hierarchy with their male counterparts.

Table 1. Gender and IT education sub-category constructs

High Level Construct	Sub Category Construct
Personal Data	
School Place Data	Student Learning Experiences (Environment and Classroom) Student Support Structures (Faculty, Role Models and Mentors for Students, Institutional and Community Response)
Shaping and Influencing Factors	
Personal Characteristics	Personal Attributes (Student Self Confidence, Student Images and Stereotypes of IT)

Support Structures of Students

Researchers have found that role models and mentors constitute a powerful support structure that has a positive influence on the retention of females in post-secondary IT education (e.g., Beise et al., 2000; Symonds, 2000; Vest & Kemp, 1999). Role models provide confirmation that women can succeed in technical disciplines and encourage their persistence in the program (Cohoon, 2001, 2002). Mentors are also a powerful support structure that influence the retention of women in IT education. Mentors provide encouragement in a genuine and sincere manner that transforms the way a woman views her connectedness to a technical discipline (Townsend, 2002).

Having faculty who enjoy teaching is also an important influence on the retention of women in post-secondary IT education. Departments with faculty reporting high degrees of personal satisfaction tend to have lower student attrition rates (Cohoon, 2000, 2001, 2002). Quality teaching helps overcome the disproportionately negative effects of unfavorable environments. Female students can also be influenced by accessible and motivated teachers. Faculty who promote interactions among classmates and develop learning communities and other forms of peer support for students also have an influence as they help to foster friendship and support networks that provide effective retention of women in technical programs (Ahuja et al., 2004; Cohoon, 2002).

Institutional and community resource support also has an influence on the retention of females in post-secondary IT education. Educational programs with adequate resources and student organizations, the use of the local job market, and volunteer opportunities all contribute to increased retention rates. The more support women receive from institutional and community resources the higher the female retention level of IT educational programs. Likewise, programs with strong institutional support and adequate resources have a positive influence on the retention of female students (Cohoon, 2002; Frieze & Blum, 2002).

IT educational programs with active student organizations also have a positive influence on the retention of female students in post-secondary IT education (Frieze & Blum, 2002; Gabbert & Meeker, 2002). For example, at Carnegie Mellon University a student leadership advisory council called the Women@SCS Advisory Council was formed to build a community to act as the driving force behind proactive efforts to improve the academic and social climate for women in the computer science department. The Council holds various mentoring events and activities such as freshmen orientation, Big Sisters/Little Sisters, school help sessions, dessert study breaks, invited speaker series, conferences, and outreach programs. As a result, the Council fosters a supportive community that promotes the academic success of women in computer science by improving the academic and social climates (Frieze & Blum, 2002).

FUTURE RESEARCH

This article has discussed several factors that influence the retention of women in post-secondary IT education in order to build on the Individual Difference Theory of Gender and IT. This analysis has attempted to go beyond the identification of societal messages that operate at the group level of analysis to also understand the variances at an individual level of analysis. In doing so, several sub category constructs have been added to the conceptual framework of the Individual Differences Theory of Gender and IT (see table one).[3] Future research plans include the continued building of the Individual Differences Theory of Gender and IT to more fully account for gender and IT education issues in order to conduct empirical investigations.

CONCLUSION

The concerns of IT worker shortages and the importance of diversity as a key component of the American economy highlight the utmost importance of attracting more women to IT careers. An initial step in this process is to recruit and retain more female students in IT educational programs and in the IT workforce. In order to do so, it is important for researchers, policy makers, and practitioners to understand the factors that influence women's choices to pursue IT degrees. The factors that have been elucidated in this article can be leveraged when recruiting and marketing to potential students as a way to encourage more women to consider a technical curriculum. They can also be used to reshape educational institutions and the IT workforce to better accommodate female recruitment and retention.

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KEY TERMS

Conceptual Framework: The basic structure of concepts of a given theoretical perspective.

Individual Differences Theory of Gender and IT: A social theory developed by Trauth (2002; Trauth et al., 2004) that focuses on within-group rather than between-group differences to explain differences in male and female relationships with information technology and IT careers. This theory posits that the underrepresentation of women in IT can best be explained by considering individual characteristics and individual influences that result in individual and varied responses to generalized environmental influences on women.

IT Education: Educational programs including, but not limited to computer science (CS), management information systems (MIS), information sciences and technology (IST), and computer engineering.

Level of Analysis: Research agendas and projects in various domain areas of individuals, groups, organizations, inter-organizations, and societal levels (Walsham, 2000).

Post-Secondary Education: University or college educational experiences, which follows secondary education such as high school.

ENDNOTES

1. For instance, the influence of environmental context in the underrepresentation of women in the IT workforce (Trauth et al., 2005), the role of parenthood (Quesenberry et al., 2004, 2006) and ubiquitous computing in work-life balance (Quesenberry & Trauth, 2005), and the role of social networking in the IT profession (Morgan et al., 2004).
2. The learning environments include the physical surroundings, psychosocial conditions, emotional conditions, and social or cultural influences present in a learning situation (Barker et al., 2002).
3. The full conceptual framework for the Individual Differences Framework can be found in Trauth et al. (2004).

Females on Technology Courses in UK Colleges

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INTRODUCTION

This article reports the findings of a funded research project carried out in two further education (FE) colleges in the North West of England. The under-representation of women in the technology sector has been the focus of various initiatives in the United Kingdom (UK) over the last 30 years, and FE, with its emphasis on vocational and practical skills, could be seen as an effective route to redress this imbalance. However, data from colleges continues to show that student females are also under-represented on technology courses in the sector. The project is seeking to gain a greater understanding of the experiences of young women on a number of technology courses where the majority of students are male. The outcomes of the research are intended to inform the FE colleges' developing strategies on how to improve the recruitment and retention of females, so helping to redress the gender imbalance on the technology courses in the study.

Research studies of this nature are rare in the FE sector, as it is largely a neglected field of study for educational research in gender and technology. In this project, we provide a forum in which the experiences of the female students in the sector can be discussed. The research focuses on the young women who "have arrived" and are currently studying technology subjects in the colleges. We report that gendered notions of technology courses still prevail and these have an impact on the choice of course, progression to technology industries and issues of confidence with technology. Overall, we highlight some of the issues that make the female students' experience of occupying "male spaces" an uncomfortable one.

BACKGROUND TO THE STUDY

This research is based on the experiences of women in business and creative technology courses in two large general FE colleges in the North West of England. The FE sector in the UK provides education and vocational training for the post-16 age group. It is the largest sector in UK education, with more than 6 million learners, and is seen as "the engine room for skills" of the UK workforce (LSC, 2005, p. i). The emphasis is on vocational study, and its population includes both 16-19 year-old learners and adult learners as part of the UK government strategy of lifelong learning.

In this article, we report on the positive choices to study technology courses made by the young and mature women who participated in our study and their subsequent experiences. The study has investigated the rationale for our students' choice of subject as well as their future career aspirations, their confidence with technology and their experiences of studying in a field that has a "dominant masculine culture and how these factors influence their participation and progression in that field.

Theoretical Framework

The context of this research lies in the well-documented under-representation of girls and women in the field of IT education generally. Evidence shows that in spite of repeated initiatives to encourage women into technology, males dominate the use of technologies in all areas of society (Benn, 2004; EOC, 2004; DfEE, 2001; Connolly & Hellawell, 2001; Wilkinson, 2001). Despite a growing trend of women's increasing participation to higher education in the last 10 years, in 2001, only 21% of undergraduates taking a first degree in computing, engineering or technology subject areas in the UK were women. While the UK government is launching new initiatives to attract more women to information technology industries, occupational segregation prevails in many areas associated with technology (EOC, 2004). The Equal Opportunities Commission (EOC, 2004) recently reported that the current proportion of women working in information and communication technologies (ICT) occupations is 15%, and in the spring of 2003, 151,000 women were working in ICT occupations, compared with 834,000 men. Continued occupational segregation restricts the pool of likely candidates and damages Britain's competitiveness as it continues to contribute to skills shortages (EOC, 2004).

Social studies of the relationship between gender and technology are well developed and demonstrate the complexities of researching in this area. Researchers adopt several theoretical and methodological positions. Some provide evidence that technology is not gender-neutral (Cockburn, 1985; Wajcman, 1991, 2004; Woodfield, 2000). Others argue that the dominant discourses around the use and implementation of ICTs are masculine (Clegg & Trayhurn, 1999; Clegg 2001; Grundy 2003), and that "computers, like cars and other forms of hardware, constitute a naturalised part of male heterosexual identity" (Clegg, 2001, p.314). No matter which way we interpret the findings, the situation remains less than optimistic and, as Wajcman points out, "the connection between masculinity and technology, reflected in women's under representation, is still pervasive" (Wajcman, 2004).

Existing research tends to concentrate on females in higher education, but it is clear (Ball, Davies, David & Reay, 2003; David, Ball, Davies & Reay, 2003) that gendered notions are formed earlier than this, and this limits the numbers of females applying to technology courses. Students from FE colleges make up a significant percentage of applicants to university courses, and it is therefore important to explore the rationale for students' choice of subject and their future career aspirations. Furthermore, we want to explore how issues of confidence with technology and the experiences of studying in a field that has a "dominant masculine culture" affected those career aspirations.

THE CASE STUDY

Table 1 lists the selected courses and student numbers by gender for the years 2002-2003 and 2003-2004. More information about the courses can be found in the Terms section.

The table shows that the gender imbalance persists to higher and lesser degrees depending on the course and the focus on technology; it would appear that where there is a greater emphasis on technology on the course, there are fewer female students.

Table 1. Enrolments on technology courses

Course name	Level	% Female students 2003-04	Total students 2003-04	Females 2003-04	% Female students 2002-03	Total students 2002-03	Females 2002-03
College 1							
ICT GNVQ Foundation *	1	31%	39	12	20%	41	8
ICT GNVQ Intermediate *	2	21%	48	10	17%	35	6
ICT AVCE *	3	22%	50	11	13%	52	7
ND ICT Practitioners *	3	0%	29	0	0%	31	0
College 2							
HND Music & New Media	3	56%	36	20	69%	35	24
ND Music Technology	3	21%	72	15	22%	64	14
ND Media	3	55%	64	35	47%	62	29
ND for IT Practitioners*	3	17%	23	4	26%	31	8
AVCE ICT *	3	27%	11	3	17%	23	4

Methodology

The main focus of the data collection methods was semi-structured interviews with female students nearing the end of their program of study. The research team was led by two researchers, one from the higher education (HE) sector and the second from the FE sector, together with several FE tutors who worked closely with the students. A total of 32 interviews were conducted, made up of 10 general national vocational qualification (GNVQ) intermediate, 5 GNVQ foundation, 10 advanced vocational certificate of education (AVCE) IT, 3 music technology, 4 music and new media management.

Additional background data was collected by surveying full cohorts of students, both male and female. The asterisked courses in Table 1 are courses where students completed the survey questionnaire. Survey response rates were close to 100%, as questionnaires were distributed and filled in during tutorial sessions.

Previous studies of post-16 groups have found that educational choice is related to cultural and social background, with links to ethnicity and class (Ball et al., 2003), and that gender issues are highly significant in the processes of choice of higher education (David et al., 2003). Parents, teachers, guidance advisors and peers, as well as the students' likelihood to do well in a particular subject, are all cited as factors which influence student choice (McGrath & Millen, 2003). In choosing technology courses, teachers' and parents' attitudes toward technology subjects are said to influence decision making. In our study, many suggested that their parents were important in influencing their choice of course, although there was no noticeable difference in the strength of influence of mother or father.

My mum encouraged me to go to college, I tried hairdressing on the choices course for six weeks and didn't like it so I preferred IT. (GNVQ Intermediate student)

Other students had "fallen" into IT by purely by accident. It has been reported elsewhere that the reluctance of girls to embrace the computer has been perceived as a problem of girls' confidence; others suggest that girls make conscious choices to reject the subject (e.g., Wilson, 2003). Knowing about a course or prospective career is obviously an important issue. One of the Music Technology students who is a mature student, age 23, commented that she had not chosen the course earlier because "No one presented it to me," (Music technology student—level 3).

All the students interviewed had met either the course leader or one of the tutors at their interview. We were surprised to hear the comments of one of our female students about the course she was about to embark on (IT AVCE).

I couldn't believe that he [male tutor] said, 'It was a lad's course.'

She went further to say,

There were a lot of girls being interviewed at the same time as me, but they didn't come on the course.

The girls were asked why they didn't think females enrol in technology courses. Just two examples of results were:

Not interested because it's a boy thing,

and

A lot of girls think it's too technical and that they wouldn't be able to do it.

However, experiences were not always negative:

The course leader (male) encouraged me to enrol, and so I did. (Music technology—level 3)

Course Culture: Girls in Boys' Spaces

In both colleges, female tutors and course leaders were in the minority. Most personal tutors were male, and a common comment was: "I would rather have a woman to talk to" (GNVQ intermediate student). Some of our students found that working in a predominantly male student group presented "problems" or "perceived" problems, some of which had severe consequences on their course choices, as exemplified by this comment:

I could have gone straight onto the AVCE Advanced course but there were no other girls on the course that year so I did an extra year on the Intermediate course (GNVQ) so that I would have some female company. (AVCE student)

This decision has major implications for the student's future and questions how girls' perceptions or their actual experiences of working with male students might influence their career choices and academic progression. It leaves us to ask, how many other girls have made a similar choice or been influenced in this way?

Another student commented that as a female you needed to be "confident, brash and then you won't get beaten by them" (GNVQ intermediate) and "you have to push yourself and make your voice heard." (GNVQ intermediate). It is clear that female students have to be different or find a way to "fit" into this male domain. We were surprised to find that not one of the students who were studying at level 2 said they intended to pursue a career in technology. More seriously, their current courses did not appear to be changing their minds.

Confidence with Technology

We know from examination results and comments from tutors that girls often do better than boys on technology courses, but often, the girls themselves don't believe this. In the study, we found that many of our female students, particularly on level-2 courses, perceived that they lacked confidence with technology and even that they were "less able" than the boys. They often told us that boys were better at using technology than girls. At this level, there was little sense of boys helping the girls to do the work or improve their skills, and indeed, little sense of integration of males and females. Several female students said they struggled with the technical aspects of their courses. However, a few were more positive and said that their confidence in using technology had increased during the course.

Level-3 female students were more confident in their use of technology, although one student described herself as "weird" because she was good at using technology. Another level-3 student commented that her male friends were always there (in the studio) "instantly at the technology" and she claimed that, as a female, it was "easy to take a back seat," but suggested she was different in that she was "quite forceful," suggesting she pushed her way in.

FUTURE TRENDS

The study has revealed a number of factors that affect our students in technology courses. Students' first impressions are gleaned from the way the course is described and presented in the college literature. The application and interview processes may reinforce these impressions and we have seen they can sometimes meet with discouragement and negative messages. We have seen that these can continue into the courses themselves, where our female students find males seriously outnumber them, a lack of positive female role models and a male-oriented and -dominated culture.

As Grundy (2003) suggests, we should look more closely at how we describe the subjects to potential students both verbally and in the course literature. We would also suggest that initiatives to inform parents, career advisors and subject teachers are used to ensure that those who advise our potential students are fully informed about the technology courses and career choices open to young women. Such steps might combat some of the gendered perceptions that our students suggested were still held by most of their peer group. Taster sessions are common in colleges to attract students, but colleges may need to provide taster sessions or college days specifically aimed at girls.

Other issues are more problematic; for example, we see a self-perpetuating cycle of a lack of female role models contributing to fewer students being interested in technology and, therefore, not interested in pursuing technology as a career choice. This inevitably reduces the availability of potential female role models for the future.

Equally if not more problematic is how to change the "lads' culture" of the courses. This is not new to technology courses or to the computing industry, where it is said that the jargon and culture of the subject of IT and computing excludes females (Grundy, 2003; Woodhead, 2002). There is no doubt that our findings suggest that there are still very gendered perceptions of these courses, implying that they are male spheres. These gendered perceptions extend to career advisors and to parents, many of whom have little experience of technology and the huge range of related careers. Our findings leave us feeling that technology courses in colleges are uncomfortable places for the young women in our study. To change this is a formidable task, but we can make some suggestions, such as positive action to educate career and student advisors, ensuring that female tutors are teaching in the courses; and the implementation of strategies to manage "laddish" behavior of the boys in class to make the young women in these courses feel more comfortable. We must ensure female students have equal access to technology and that measures be taken to ensure their confidence in using technology is built from the start of the course.

The colleges intend to act on the outcomes of the study and carry out further research with female students. As we have said, very few of the girls in our study will either progress to higher levels or end up working in a career associated with technology. The girls' career choices are likely to reflect their experiences on these courses; again, they must be encouraged and informed about choices available to them for future progression. A few students clearly have enjoyed their subject and intend to pursue a career in a technology industry. We call for more positive action from the career advisors and technology industries to inform young women of the range and potential of the careers available to them.

CONCLUSION

The study has provided a case study of practice that helps to explain the low levels of female participation and success on a range of technology courses in two FE colleges. Most importantly, it has revealed the experiences of female students as they study in the courses. Furthermore, the study adds to the small but growing number of qualitative studies in the UK FE sector, and therefore supports policy initiatives to raise the research profile of the sector and its practitioners.

In this short article we have presented only an outline of our research. The women we have interviewed come from a variety of backgrounds and previous experiences, yet they report similar feelings and experiences about the courses. The under representation of females in the courses clearly needs to be addressed. However, we fear that until the prevailing masculine cultures around "technology" courses—which suggest that technology has little to offer to young women—are tackled, these courses may remain perceived as "boys courses" by both male and female students, thus perpetuating their male-oriented culture.

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KEY TERMS

Business and Creative Technology: The definition of business and creative technology courses in this paper encompasses business IT/computing courses, music technology and graphic design courses. In all of these courses, the design and use of ICT is an integral part. Details of courses are below:

- **AVCE:** The advanced vocational certificate of education. Two-year, level-3 general IT course providing progression into higher education, employment or related qualifications.
- **BTEC National Diploma:** Level-3 IT course providing progression into higher education, employment or related qualifications.
- **GNVQ:** General national vocational qualification. An intermediate, level-2 qualification equivalent to five GCSEs, giving entry to the AVCE level-3 qualification.
- **Higher National Diploma:** Two-year, full-time course allowing entry into the second or third year of a degree course.

Further Education Sector: Provides vocational and academic education to post-16 learners.

Higher Education Sector: Provides academic education to the post-18 age group.

Masculine Culture: Sees technology in its widest sense, such as cars and other forms of hardware, as a naturalized part of "male heterosexual identity" (Clegg, 2001, p. 314) in which the jargon and culture of IT and computing excludes females.

Occupational Segregation: Involves both horizontal and vertical segregation. Horizontal refers to when a given gender dominates an occupation where there is little or no noticeable engagement in non-traditional occupations for women, such as engineering and computing. Vertical segregation refers to limited career progression, with women generally in the lower grades (EOC, 2004).

A Feminist Agenda for Reducing the Gender Digital Divide

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INTRODUCTION

There is little shared understanding of the term "digital divide," but this has not prevented the international community from investing a great deal of effort in projects that aim to reduce the digital divide by reducing disparities in access to information and communication technologies (ICT) (European Commission High Level Group, 1997; International Telecommunication Union [ITU], 1984, 2003; United Nations Economic and Social Commission [UN ECOSOC], 2000). The divergent rate at which ICT diffuses—the digital divide—is a reflection of broader socioeconomic divides, many of which exist within societies. The divide between men and women, rich and poor, young and old, urban and rural, literate and non-literate, also manifests itself in the digital world of media, computers, telecommunications, Internet, and jobs in software production. Information and communication flows carried by ICT are increasingly becoming an integral factor in international, institutional, and political processes. Lack of access to ICT therefore impacts on opportunities for developing countries' economic growth, wealth distribution, social empowerment, and development. It is the digital divide which largely prevents the equal sharing of knowledge worldwide and leads to "information and knowledge poverty" among certain groups. If only a select number of countries, and within them certain groups, reap the benefits of ICT while others continue to lag behind, the digital divide will continue to grow and the virtuous cycle that ICT can create will not be enjoyed by many (Millward-Oliver, 2005).

There is little acknowledgment and even less acceptance that gender constitutes an important influence in the structure of the "digital divide." At first glance, this failure to admit context may seem strange and out of step with common sense. Why should gender relations, such an important and pivotal element of social structure, that is known to influence differentiated access to financial resources, employment opportunities, education and training, water and sanitation, health care, legal status, and enjoyment of human-rights not affect access to and control of ICT? This article will explore some of the key factors that lead to gender blindness in the digital divide debate and articulate a strategic response.

ROOT CAUSES OF GENDER BLINDNESS

The first is the prevalence of the myth of *technology neutrality*. Despite evidence and academic theorising related to the social construction of technology (see, for example, MacKenzie & Wajcman, 1995) in the ICT sector, the prevailing dominant culture of scientists, technologists, and policy makers insists that ICT are universally beneficial *tools.* Although this dominant narrative flies in the face of research and lived reality, this tendency is well and truly entrenched in the mainstream of the ICT sector, and has been accompanied by hyperbole about the unprecedented contribution that ICT can make to all our lives. What is more, the assumption of technology neutrality sits as one of the unquestioned bedrocks of much ICT policy making and programming, including in the efforts of multilateral organisations that ought to know better (European Commission High Level Group, 1997; Department for International Development [DFID], 2002; ITU, 1984, 2003; Organisation for Economic Cooperation and Development [OECD], 2003; UN ECOSOC, 2000; UNDP, 2003; World Bank, 2002, 2004), especially given their rhetorical commitment to "mainstream" gender equality.

The second factor has to do with differential access to power and influence in the ICT sector. Women are significantly underrepresented in positions of power and influence within ICT producer firms, policy making institutions and knowledge centres. Men in those positions have not worked very hard as champions of gender equality. As a result, the promotion of gender-equality in ICT is not a priority. For both men and women in the ICT sector, paying attention to gender equality issues is not considered to be an issue that leads to career advancement and certainly does not dominate real politic and tough negotiations (Marcelle, 2000a, 2005). Gender analysis confirms that over the last decade (Hafkin 2002a, b; UN-DAW, 2003) those with power and influence do not consider and give priority to gender-equality in ICT policy. The issue either falls off the list completely, or is included with tokenism and patronisation when the influential bodies set out the determinants of ICT policy (G8 Dot Force, 2002; Gilhooly, n.d.; World Bank, 2002; WTO, 1998). This applies to both the international and national levels; in the latter, gender-equality machineries are often not considered to be important contributors in defining an agenda for the Information Society. Further, there is also a disparity in access to financial and human resources. For the most part, gender-equality in ICT is championed and spear-headed by campaigning and advocacy organisations and scholars. This community organises its work through networks and other loosely structured formations. Conversely, ICT powerbrokers that have a vested interest in the status quo are much more likely to occupy staff positions of well-funded organisations and to use these positions to shape the agenda. There is much still to do to transform power-relations in the ICT sector.

The third and final factor is the absence of focus on ICT and development by the broad gender equality and women's rights movement (Marcelle, 2005). It is fair to say that the women's movement has not yet prioritised these issues. Matters to do with access and control of technology are still seen as the narrow concern of "techie" women, rather than as part of the overall struggle for peace, equality, and development. This situation arises partly because there are many candidates for priority attention and the international women's movement faces many challenges. However, in addition to the clamour of other sometimes seemingly more pressing issues, some features of the gender and ICT community also contribute to this state of affairs. With the gender and ICT movement, there has been a failure to define legitimate and priority advocacy issues. This lack of focus can be in part explained by the heterogeneity of women across the globe and varying perspectives on gender-equality and women's rights. Some advocates suggest that the intersectionality of class, race, sexuality, and religion is the appropriate lens for analysis and action, while others adopt a more pragmatic stance, and suggest use of the reform objectives of gender-mainstreaming. This lack of consensus also extends to strategies and tactics (Radloff et al., 2005). There has also been a tendency to draw quite sharp lines around the boundaries of the gender and ICT community and to be less than enthusiastic in building linkages with other gender advocacy communities—trade, labour relations, human-rights, economic reform, and peace—and learning from their successes and failures. This has to do, in my view, with a misdiagnosis of what is at stake. If the gender and ICT agenda ends with improving women's non-governmental organisations' (NGOs) ability to use ICT and to increasing women's access to ICT services and facilities, and does not tackle fundamental transformation of the ICT sector, it is unlikely to attract the interest of a wider community and to be considered to be relevant, legitimate, and important.

STRATEGIC RESPONSE

Feminism is what feminists practice; in building a global feminist movement that is relevant to all women, their development and human rights, we should ensure that there is more involvement in Information Society debates at the strategic level. It is possible to reclaim Information Society discourse and programmatic actions. To do so one would need to place feminist theory and its perspectives on globalisation, power-relations, and economic reform (Kabeer, 1994; Sen & Grown, 1987) at the centre of efforts to imagine and define strategies to develop a people-centred Information Society.

Feminist perspectives provide an insightful point of departure for the radical transformation of the ICT sector. It is essential that representatives of women's organisations and advocates of social change are included in strengthening a movement for change. Transformation of the ICT sector requires more than a concern about increasing access and usage or even about reducing disparities across countries.

Radical transformation requires an explicit analysis and critique of the sector reform policies that focus on liberalisation and privatisation (World Bank, 2002; WTO, 1998). On the basis of evidence, we should identify and analyse the effects of sector reform policies on the poor, women, and other marginalised groups. This analysis will show that ICT sector reform has brought advantages for modern, middle-class women employed in the formal sector, but has resulted in little change for her sisters and brothers in rural remote communities. The movement for change should be vocal and strategic in our demands. We should let the international community know that it is not enough to hope that in the long run, the market will solve these problems, because it is now clearly evident that macro and micro reforms have distributional effects, which are not equitable. Without intervention, they fall heaviest on the poor and the disenfranchised. We should not allow telecoms to continue to be a sector where there are marked distinctions between the haves and the have-nots.

A feminist analysis would also call for more careful analysis of the root causes of the digital divide. For the most part, the problem specification and the solutions proposed have focused on the supply side, rather than including demand factors and capacity building. The World Bank has led the way in a global consensus that suggests that once changes are made in market structure, and ownership changed from state to the private sector, all will be well. There has been considerable less effort on understanding the demand-side and proposing solutions to increase effective demand. A more integrated approach is needed. If this closer integration is achieved, the constraints on the demand-side—inability to pay—are better understood, and more appropriate responses can be developed (Mansell 2003; Mansell & When, 1998). It is obvious that the inability to pay for telecoms services, like so many other aspects of hardship in developing countries, can only be solved by integrated solutions which view human development as the first priority. A profitable telecoms company, which makes no contribution to improving quality of life, would not be an asset for the citizens of the developing world. We also need to pay greater attention to understanding and specifying the conditions under which ICT produces impact, including by improving the methodologies used in programme design, evaluation, and monitoring (Ravallion, 2001; Tongia, Subrahmanian & Arunachalam, 2005).

In a feminist perspective, the process of creating an information society would be considered to be a political process in which governments and other stakeholders invest a range of capital assets in expansion of the ICT sector and implementation of facilitating mechanisms associated with increasing use of ICTs. This is well understood in countries that undertake ICT policy as a consultative process involving all stakeholders, but not grasped by countries which embark on narrowly focused technical exercises (Marcelle, 2000b). Politics is never absent at any stage in the creation of an information society. In the early stages of expanding networks and infrastructure, national interest groups will be vying for licences, and global interests will compete for market entry. Once entrants are active in the market, the political process will turn to careful structuring of a balance between public policy interests and private returns as far as setting tariffs and universal service policy are concerned. Grasping this political dimension of the information society, carefully mapping patterns of power, influence and resistance to change are essential for the radical transformation of the ICT sector.

CONCLUSION

The question becomes not what ICT can do for women, but what can women and social change movements do for the ICT sector. The answer is clear—a gender perspective can improve the responsiveness and integration with the goals of human development, so bringing the ICT sector into the vanguard of development.

The challenges posed by the gender digital divide are far-reaching and fundamental. The ICT sector needs to build a community by integrating with social and development movements, including women's organisations, and by formulating plans for the sector which articulate with broad development goals. To do this, the sector needs to develop better conceptual tools and frameworks and to change its ways of working. A developmental agenda for the ICT sector should start from economic, social, and cultural realities.

By advocating an action orientated approach to taking on the gender digital divide issue, I argue that we will in the process tackle the myth of technology neutrality and engage with the power brokers in the ICT sector and reform power relations in the sector, including by occupying positions of power and influence and using those positions for the benefit of all people. If these efforts can be used as a means of broadening the gender and ICT community, and raising the profile of the relevance of Information Society debates within the broad gender and development community, there is a much improved chance of getting to a point where the gender differences in access to and control of ICT do not exist, and the ICT sector makes a more meaningful contribution to human development and peace.

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KEY TERMS

Digital Divide: The digital divide is used to refer to the disparity in production, access, control and effective use of information and communication technologies. These disparities mirror economic, social and political global realities and arise because of unequal ddistribution of wealth, knowledge, power and opportunity across the globe. Within countries, the divide is manifested in significant divergence in access between economic classes, income levels, and racial groups and between urban and rural communities. There is also gender divide, in as far as poor women make up the majority of the urban and rural poor whose needs are not well understood and who are not able to afford access. Women are also disproportionately underrepresented in the production and research segments of the ICT sector.

Gender Blindness: Gender blindness results when socio-economic analysis and development programming does not take gender relations into account. It results in development policies and programmes not meeting the different needs of both women and men.

Gender Relations: Gender relations refer to the relationships between men and women, their access to resources, their activities, and the constraints they face relative to each other. Gender analysis provides information that recognizes that gender, and its interrelation with race, ethnicity, culture, class, age, disability, and/or other status, is important in understanding the different patterns of involvement, behaviour and activities that women and men have in society. An analysis of gender relations provides information on the differentiated conditions that woman and men face, and the resulting differences in the effects of policies and programmes.

Human Development: Human development is the process through which people enjoy greater opportunity and choice, particularly in terms of self-expression, self-actualisation, and access to information, knowledge and wisdom. Development takes place when human beings create conditions that enable them to lead long, healthy, creative lives and to enjoy a decent standard of living, with freedom, dignity, self-esteem and the respect of others, without compromising the ability of future generations and the natural environment.

Information and Communication Technologies (ICT): Information and communication technologies (ICT) consist of a complex and heterogeneous set of goods, applications and services used to produce, distribute, process and transform information. The ICT sector consists of segments as diverse as traditional telecommunications, television and radio broadcasting, computer hardware and software, computer services and electronic media (e.g., the Internet, electronic mail, electronic commerce and computer games), as well as the content of these media.

Information Society: Information society consists of the set of social, cultural, political, institutional and economic arrangements that facilitate rapid and widespread diffusion of information and communications technologies. Creation of an Information Society has the potential to provide significant benefits for, and have major impact on, the priority developmental goals in poor countries. However, it is not automatic and the public policy challenge facing developing countries is to shape the evolution of the information society to produce maximum benefit.

Intersectionality: Intersectionality holds that forms of oppression within a society, such as those based on race, gender, religion, sexuality, class, are interrelated rather than acting independently.

Sector Reform: Sector reform is a coordinated set of activities that result in significant changes in industry structure and practice in the ICT sector. The main pillars of sector reform as espoused by key architects such as the World Bank and the WTO include shifting operations away from governments; reducing monopoly power; separating and strengthening policy and regulatory functions; and introducing competition into markets and increasing private sector participation.

Social Construction of Technology: Technologies are shaped by social and political forces. As a result, moral values and interests are embedded in their design, production and use.

Technological Neutrality: Technological neutrality considers technologies to be a set of value-neutral tools, which can be used for better or worse. In this perspective, technology is considered often to be a coherent and comprehensive phenomenon, which acts as a force that determines culture and society.

Feminist Standpoint Theory

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INTRODUCTION

Feminist standpoint theory is an epistemological view set forth in the late 1970s and early 1980s described as "an engaged vision of the world opposed and superior to dominant ways of thinking" (Ruddick, 1995, p. 129). Its development was influenced by Marxist thought, specifically the idea that the worldview of the ruling class is compromised by its vested interest in upholding the current class structure. The proletariat, who has no such interest, is able to interpret reality from the standpoint of its own experience as well as that of the ruling class because the ruling class' ideas are widely inculcated and presented as "objective," advancing the view that social conditions are as they are, and they cannot be otherwise. This naturalization of the ruling class' ideas bolsters and affirms its privilege. The proletariat can inhabit both its own and the dominant perspectives, putting it at a more ideal epistemological and political vantage point.

Drawing upon this line of Marxist thought, feminist standpoint theory holds that women's social development and experiences are different from men's, and these experiences, taken with the sexual division of labor and women's portion of this work, including mothering, homemaking, and other emotional and relational labor such as nursing and social work (Hartsock 1983, 2004), enable women to interpret the material world from a unique standpoint. Implicit in this postulate is the assumption that men are the ruling class, and the dominant worldview is masculine. The feminist standpoint, its proponents argued, could be used as a methodology to make more accurate, holistic, and socially responsible knowledge. At the heart of feminist standpoint theory, Braidotti (2003) argues, is the emphasis on the difference between men and women and the focus on women's experiences as a means to knowledge production. Belenky, Clinchy, Goldberger, and Tarule (1986), Chodorow (1978), and Gilligan (1982) extended the feminist standpoint project by studying women's epistemological, psychological, and moral development, respectively, and the theories that emerged from their studies in particular have had considerable influence on early work in gender and information technology.

BACKGROUND

In the late 1970s and the 1980s, feminist standpoint theorists in psychology and education worked to correct what they perceived as male bias in theories of development and, in general, the "dominant intellectual ethos" of the time (Belenky et al., 1986, p. ix). In response to influential theorists such as Freud and Piaget, these researchers built theory that was grounded in women's experience. Chodorow (1978) theorizes women's development from a psychological perspective. She describes the "reproduction of mothering" as a built-in facet of girls' and women's personalities; because girls are mothered by women, they see their mothers as role models and, in turn, themselves desire to mother. Chodorow argues that the reproduction of mothering is a social psychological process that helps to keep gender hierarchy in place as long as women are the ones expected to care for children. That children are mothered by women has strong implications for the personality and development of girls. Girls take a much longer time to separate from the mother than do boys and therefore see themselves as more continuous with their mothers. Chodorow points out that due to the continuity and identification with their mothers,

> *girls emerge from [childhood] with a basis for "empathy" built into their primary definition of self in a way that boys do not. Girls emerge with a stronger basis for experiencing another's needs or feelings as one's own (or of thinking that one is so experiencing another's needs and feelings).* (p. 167)

Because a girl is mothered by a woman who anticipated her needs as an infant and child, she in turn learns to anticipate and meet others' needs.

Gilligan (1982) explores women's development with attention to ethics and morality. Based on her interviews with children and women, Gilligan argues that the tacit prescription that women should care for others and prioritize others' needs and desires before their own emphasizes "the concepts of responsibility and care in women's construction of the moral domain" and a "close tie in women's thinking between conceptions of the self and of morality" (p. 105). Gilligan theorizes that if women think of ethics and morals in terms of rights, or what they are themselves entitled to, they can balance ethics and morality between the needs of the self and the needs of others, going from "the paralyzing injunction not to hurt others to an injunction to act responsively toward self and others and thus to sustain connection" (p. 149). She argues that if women do not see moral decisions in terms of what they are entitled to, the problem she identifies will continue. First, women will, when making moral decisions, continue to sacrifice their own needs and wants for their perceived obligations and responsibilities, and continue to see their actions primarily in terms of how they will affect others. Second, masculine bias will continue in theories of development if researchers fail to take into account women's perspectives and experiences, or women's "voice," resulting in theories of human experience that lack the appropriate complexity (Gilligan, 1982, pp. 173-174).

Belenky et al. (1986), after noticing that "women often feel alienated in academic settings and experience 'formal' education as either peripheral or irrelevant to their central interests and development" (p. 4), studied the way women acquire knowledge and experience knowing. They found a continuum in women's epistemological development that goes from silence, a metaphor taken from Olsen's (1978) study of the history of women writers, which they define as "an extreme in denial of self and in dependence on external authority for direction" (p. 24); to received knowledge, or listening to authorities and accepting their explanations as definitive; to subjective knowledge, in which women start to develop an inner voice and gain some authority as knowers. The next category is procedural knowledge, which they divide into separate knowing and connected knowing. Separate knowers have "procedures for making meaning [that] are strictly impersonal. Feelings and personal beliefs are rigorously excluded" (p. 109). Connected knowers, the most highly developed knowers in their taxonomy, see themselves as authoritative and as having a personal stake in knowledge. They value the personal and emotional and bring them to what they seek to understand. Connected knowers understand that they play a part in shaping knowledge. Belenky et al. argue that a pedagogical approach geared toward collaborative learning and experiential knowledge, an approach that stresses "connection over separation, understanding and acceptance over assessment, and collaboration over debate" (p. 229), is best suited to women's learning styles, and that educators can and should include women's experiences and learning styles in pedagogical theory, curriculum design, and teaching practice.

FEMINIST STANDPOINT THEORY AND COMPUTER CULTURE

Wajcman (1991) claims that "technology is more than a set of physical objects or artefacts. It also fundamentally embodies a culture or set of social relations made up of certain sorts of knowledge, beliefs, desires, and practices" (p. 149). Much of the feminist work in information technology has been concerned with technology as culture, or, as Lay (1996) terms it, computer culture. Feminist researchers have synthesized the insights offered by feminist standpoint theorists, especially those reviewed above, with men's and women's attitudes toward computing and experiences with information technology in educational, domestic, and occupational settings. They described values and practices often associated with computer culture—competition, individualism, and hierarchy—as masculine, and they criticized the exclusion of the values of connection, relationality, and collaboration found to be common among women. The association of computing with masculinity goes back to childhood for many women, when girls often have more responsibilities at home, and "girls' extracurricular activities are generally much more restricted than boys'" (Wajcman, p. 154). Girls are not encouraged to play computer games, participate in computer camps, and engage with the computer as much as boys are (Wajcman, 1991). Moreover, most computer games are designed using the masculine values of hierarchy and competition. Computer science instructors, for the most part, have not used feminist theories of women's development in their course design and pedagogy and have, perhaps unwittingly, perpetuated gender stereotypes surrounding boys, girls, math, and science, alienating girls (Wajcman). This early experience with computers in the home and at school is crucial because it establishes a pattern that tends to continue into adulthood; to wit, historically, and even now, men outnumber women in technical professions.

IT research influenced by feminist standpoint theory offers a genealogy of how computer culture is rooted in masculine epistemological tradition. Lay (1993) points out the "remnants of scientific positivism" in computer culture (especially in the development of hardware and software) as well as the tendency to divide the world into dichotomies that are "either objective or subjective, allied with nature or culture, governed by emotions or rational thinking, these dichotomies privilege what society labels as masculinity" (p. 222; see also Wajcman, 1991). Selfe and Selfe (1996) add that computer production and networking has its origins in the military, with the motive of making military communication more efficient in times of war. Dominant knowledge, which feminist standpoint theorists would argue is masculine, structures how knowledge about computers gets communicated, and one can see evidence of this gendering in the selection of interface metaphors, including the violent masculine metaphors *kill* and *abort*. Gerrard (1999) cites Selfe and Selfe's challenge to imagine a computer with the interface metaphor of *kitchen* or *workbench* rather than *desktop*, each of which would gender or class the computer differently. However, while the language that is used to communicate technical knowledge reveals much about the culture in which tools are embedded, the relationship between language and practice is not a transparent and deterministic one (Wajcman). Education is an important context to study, which feminist researchers of information technology have done using standpoint theory.

Lay (1996) identifies several differences between men and women's learning styles: She critiques top-down programming for its hierarchical, masculine thought style and points to Turkle and Papert's study of computer programmers, noting that most computer learners classified as "bricoleurs" are women. Bricoleurs "tend to anthropomorphize the computer and seek transparency, closeness, and visual manipulation when learning and using the computer" (pp. 68-69). Instead of top-down programming in which the programmers write modules of code conforming to the designer's plan, bricoleurs prefer moving the modules around and rearranging them until the program is completed. Turkle (1988) describes this kind of interaction as "a relational encounter," "an artistic, almost tactile style of identification with computational objects, a desire to 'play with them' as though they were physical objects in a collage" (p. 50). Men are more interested in the computer itself, whereas women are more interested in the computer as a tool or means to completing a task. In the study of computing, women sometimes feel alienated; Turkle argues that they see not only the computer itself, but all its cultural associations. She writes:

> *[w]hen women look at the programming virtuosos around them, they, unlike men, see themselves as cut off from a valued learning style. Male risk taking is equated with computational "intuition." In educational and professional environments where hackers present an image of "the best," women often see themselves as lesser. They see themselves as "just users," as competent but not really creative.* (p. 49)

Lay (1996) recommends that computer documentation textbooks accommodate diverse learning styles, including those commonly associated with women, which value relationships, collaboration, and nonhierarchical programming methods.

Studies in computer-mediated communication have also drawn heavily upon feminist standpoint theory, arguing that differences sometimes exist in the ways men and women communicate in networked environments. Herring (1996), who admittedly does not use standpoint theory in her work, has gestured toward two types: the informative male and the interactive female. The informative male often states his opinions as fact, makes clear assertions, uses fewer emoticons, and takes a more critical stance toward information introduced into the discussion. In contrast, the interactive female couches her opinions in leading questions, makes attenuated assertions, hedges (uses *perhaps*, *maybe*, *it seems*), uses more emoticons, has a more personal or interpersonal style, and is more interested in exchanging information than criticizing it. Herring qualifies these types, however, by noting that men and women use both communicative styles depending on the situation, and her research has shown that, in a group discussion, the minority gender conforms to the majority gender's norms even if the minority gender is male. LeCourt (1999, pp. 163-164) concedes that an "invitational" style, when used by a woman, could be associated with "'women's' ways of knowing," but warns that this association "provides an opportunity for [women's] discourse to be positioned as 'lesser.'" Feminist researchers in rhetoric and composition have acknowledged this inclination to hierarchize differences but have still taken feminist standpoint theory seriously in their studies of writing and discussion in electronic environments. Grigar (1999) found that her female students used e-mail to reach out to other students and to her, their teacher. Gerrard (1999) and Grigar argue that teachers can use e-mail to forge caring, nurturing relationships with students. Gerrard (pp. 387-388) also argues that using hypertextual forms of writing, which can be chaotic, nonlinear, and sometimes collaborative, can provide a welcome contrast to "the linear, argumentative essay, which rhetorical theorists have argued is a 'masculine' form—hierarchical, contentious, and competitive." However fraught focusing on differences between men and women may be, many rhetoricians of technology have found standpoint theory useful in forming pedagogical theories. Lay (1996) argues that Belenky et al.'s (1986), Chodorow's (1978), and Gilligan's (1982) theories have value because they are valid for many men and many women.

FUTURE TRENDS

In recent years, feminist standpoint theory has fallen out of favor as a methodological tool in feminist research due in part to the influence of postmodernist thought, which eschews essentialist, reductive, dualistic, deterministic thinking, favoring instead multiplicity, complexity, and contextualization. Feminist standpoint theorists have stated explicitly that they do not mean to propound a view of biological determinism. Rather, they argue, any differences that may exist are socially constructed and perpetuated, and therefore are able to be overcome with more egalitarian social practices. Furthermore, feminist standpoint theorists emphasized that differences do not have to be constituted in a superior-inferior dichotomy.

However, standpoint theory has still been criticized as essentialist. Critics of standpoint theory have argued that it tends to overgeneralize about men's and women's behavior, and that focusing on cognitive differences minimizes the importance of social context. Wajcman (1991), for example, highlights the fact that technology as culture has been closely associated with war machines and weapons, usually gendered masculine, but that women have served in combat and provided much help to war efforts. Men, on the other hand, have historically been more active than women in organizing mass war-protest efforts. Critics of standpoint theory also argue that no one has epistemological privilege—not even women—and that dichotomous, oppositional thinking ends up reifying gender hierarchies rather than dismantling them. Additionally, standpoint theory tends to generalize about women as one group and does not account for differences among women. Hekman (1997, p. 341) writes, "[p]articularly among younger feminist theorists, feminist standpoint theory is frequently regarded as a quaint relic of feminism's less sophisticated past." While feminist standpoint theory was influential in early studies of gender and information technology, it is unlikely that it will continue to be; most feminist researchers view gender as performative. In future research, if standpoint theory is used at all, it will be used in a carefully qualified, historicized, tactical manner, and not likely as a primary theoretical framework.

CONCLUSION

Feminist standpoint theory is rarely used in current research on gender and information technology, but it is a significant part of the intellectual history of this field. Markham (2003) says that Internet researchers:

need to place our research in history; ahistoricity is a problem. Go to other researchers' work even if you're working with a new technology—other researchers have already thought through most epistemological and theoretical problems. There's a tendency in Internet research to reinvent the wheel, or invent a method to use.

Standpoint theory has historical value not only because it is a large part of the foundation of gender and information technology, but also because it produced windfalls for gender theory in general: It "started the conversation about situated knowledges" (Hekman, 1997, p. 344), and it helped to bring issues of race, class, ability, and sexuality into feminism.

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KEY TERMS

Biological Determinism: The idea that differences between men and women are innate, biological, and therefore insurmountable.

Computer Culture: The cultural context in which computing practices emerged and continue to take place.

Computer-Mediated Communication: Communication that takes place in networked, electronic environments, sometimes on the World Wide Web, but not necessarily.

Essentialism: The belief that all members of a group share common attributes. For gender, men might be seen as naturally stronger, more aggressive, logical, and independent, women as weaker, more passive, emotional, and more dependent on social relationships.

Performativity: The idea that gender is a learned, daily act grounded in social norms of heterosexuality, femininity, and masculinity rather than biological sex. Taken by Judith Butler from the work of linguists J. L. Austin and John Searle.

Positivism: The epistemological view that argues that the only valid knowledge is that which applies formal rules of logic to empirically observable facts in material reality.

Situated Knowledges: Refers to the argument that knowledge is produced in social contexts and from particular social locations that influence how the knowledge is shaped.

F

Five Perspectives on Women and Men in the IT Workforce

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INTRODUCTION

The opportunities in a variety of information technology (IT) occupations, such as software engineer, systems analyst and consultant, combined with increased employer interest (and need) for workers whose essential skill is knowledge and not brawn, intimate that IT is a "level playing field." That is, simply possessing IT-related skills might mean that a worker's gender would not be a discriminating characteristic for job-related outcomes in IT work. The perception of high-paying and gender-neutral work should encourage women to enter IT fields. This should be magnified by the increases in resources (public and private) designed to enable women to acquire IT-related skills. For example, early introduction programs, such as the Girl Scout's STEM program, encourage entry into IT work through newsletters, career information and mentoring opportunities for young girls in the subjects of science, technology, engineering, and mathematics (Girl Scouts of America, 2004).

BACKGROUND

With STEM and other early intervention educational programs, women should be participating in advanced math and science courses on par with men (Leventman, Campbell, Cullinane, & Perry, 2004). Increased access to educational resources in mathematics and science should prepare women to participate in equitable proportions as their male counterparts in IT. Nevertheless, evidence shows that 33%-41% of the entire United States (U.S.) IT workforce are women, and only 25%-30% of the professionally trained IT workforce (Information Technology Association of America 2001)[1]. This suggests that women are underrepresented in IT, regardless of increasing availability of high-paying positions in IT fields and various supportive factors in the social environment. Moreover, given the number of people who enter the IT workforce with post-secondary degrees in English and history, the underrepresentation of women in IT work may not be explained solely by the declining rates of women obtaining bachelor's degrees in computer science and related programs (National Science Foundation, 1996; Eliassen, 1997).

One conclusion from these observations would be that gender seems to make a difference in employment and job opportunities for the professional IT workforce. We agree, hypothesizing there are interactions among institutional characteristics associated with education, families, industrial markets and workplace organizations, and that these frame patterns of work-related outcomes for the professional IT workforce. The pattern of outcomes, though, tends to be different for women and men. Before elaborating on our model, we first review other theoretical viewpoints, including human capital, essential differences, social constructionist and techno-feminist, which are often referenced when discussing work-related outcomes for workers in general.

Human Capital Perspective

The human capital perspective is premised on a cost-benefit analysis for investing in skill enhancement (Becker, 1962). For example, if the anticipated returns from higher education or firm-specific training are greater than the costs, a person theoretically would be likely to invest in additional education or training. The benefits from skill enhancement could include higher earnings, promotions, increased job autonomy and higher job satisfaction. The human capital perspective explicitly suggests that work-related outcomes depend largely on IT workers' quantity and quality of human capital investment. Implicitly, the human capital perspective assumes that neither gender nor technology *per se* necessarily influence job selection or work-related outcomes.

Essentialist Perspective

In the essentialist's view, men and women have innate differences that lead to gendered outcomes. Gendered responses to stress, for example, are believed to reflect those differences between males and females. Males respond to stress through aggressive actions, and this is considered ideal for leadership positions in the workplace. Females, however, tend to befriend and pacify others in times of stress (Barnett & Rivers, 2004). Males are thought to emphasize systemizing, analyzing, exploring and governing, whereas females emphasize empathizing and nurturing others. Thus, occupational selection might find women seeking to work in settings that do not violate their feminine nature, whereas men might find that high-level organizational positions fit with their intellect and logic (Barnett & Rivers, 2004). An essentialist view suggests that a feminine nature would necessarily limit women's employment opportunities in various IT occupational fields, such as network and systems analysis, computer engineering or database administration. As with the human capital perspective, technology *per se* does not influence either job selection or work-related outcomes.

Social Constructionist Perspective

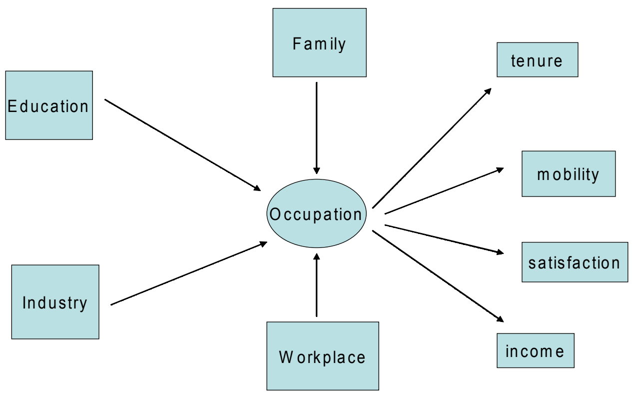
According to the social constructionist perspective, men and women are socialized by distinct social influences that ultimately lead to more valuable work-related outcomes for men than women. From this perspective, men are taught at a young age to value achievement and competition, whereas women are taught to value affiliation and social relationships (Abu-Saad & Isralowitz, 1997). Through this social process, women learn to value attachment to family, whereas men learn to value attachment to the workplace. Men are socialized to have an instrumental orientation toward work, while women are socialized to have a communal orientation that emphasizes harmony, connectedness and concern for others (Mason, 1994). As a result, women might be less interested than men in the more technical occupations (Barnett & Rivers, 2004). Since professional technical occupations are often associated with greater rewards in terms of pay, prestige and career advancement, men might have considerably more opportunities to secure better work-related outcomes than women in IT-related fields. Social constructionists also view technology as a gender-neutral phenomenon.

Techno-Feminist Perspective

According to the techno-feminist perspective, technology historically has been created and designed largely by men for specific masculine projects. In this sense, technology is viewed as an integral part of the masculine identity, whereas femininity is at minimum incompatible with most technologies (Wajcman, 1991). This gendering leads to different social relations at work and different work-related outcomes for men and women (Wajcman, 1991, 2004).

For women to successfully engage technology, they must abandon their femininity to some degree to better understand technology's masculine language and implementation. From this perspective, the implementation of technologies originates with powerful men, while technologies also convey power to those who implement them. Without specific knowledge on how to best make use of IT, for example, women cannot potentially possess power in the workplace.

Figure 1. Institutional model of IT work



Men, on the other hand, gain power over women by their acquisition of technical knowledge and competence. In this context, women might lose their desire to enter or actively participate in a technical workforce because of a masculine dominance and forgo the opportunity to acquire skills necessary to thrive in a technology field. One consequence of this "decision" could well be employment in low-skilled, low-wage occupations.

In sum, these four perspectives tend to overlook the significance of the various organizational domains, or institutions, that structure personal experiences in the workplace. They also tend to see the relationship between gender and technology as being relatively unproblematic. Importantly, we know some women do enter technology fields and are very successful, suggesting the relationship between gender and technology is problematic. Thus, we propose an institutional perspective that includes the conception of an occupational career as a life-long process influenced by key social institutions.

FUTURE TRENDS: THE INSTITUTIONAL VIEW

We advance here a fifth perspective on the relationships between gender and IT work: the institutional view. The institutional view begins with the notion that "… the responsibility for the behaviors people engage in at work and their fate inside organizations …" resides largely in the structures of the institutions surrounding them (Kanter, 1977, p. 10). Moreover, throughout their life course, men and women workers experience occupational and personal changes related to these institutions that directly reshape their career paths. From this perspective, IT is a socially constructed phenomenon that historically has reflected a masculine gender in the U.S., while simultaneously enhancing the power of certain segments of society. Questions abound today whether the role of IT in the informational global economy will lead to a more even distribution of power.[2]

As we show in Figure 1, the life course of an IT worker is shaped by institutional contexts in which they live and work, including how their IT skills will be used, enhanced and rewarded, and how they will view their opportunities and appraise their priorities with the passing of time (Kanter, 1977; Krecker, 1994; Kalleberg & Moody, 1996). The educational institutions, industrial markets, workplace organizations and families are seen as influencing critical life-course junctures and work-related outcomes.

Educational Institution

The type of educational institution where people earn post-secondary degrees has possibly significant effects on their first jobs (Feagin & Feagin, 1986; Von Hellens, Nielsen, & Trauth, 2001). Salzman (2000) reports that human resource managers hiring IT workers do, in fact, consider the type of degree as well as ranking of the educational institution during the selection process. Indeed, opportunities for certain advanced undergraduate courses, internships and career mentoring in IT throughout an individual's college experience can lead to differences in opportunities for the first job.

Barnett and Rivers (2004) argue that persistent stereotypes within educational institutions influence educational outcomes. Throughout their educational experience, women are discouraged from taking math and science courses, since these subjects are believed to be inherently masculine. But, gendered educational experiences lead to gendered occupational outcomes by discouraging women from careers in engineering and IT,while encouraging them to pursue careers in nursing or teaching that complement their feminine stereotype as nurturers.

Industrial Markets

The type of industry where IT work is done can influence the orientation and expectations of workers at critical life-course junctures. Industrial markets have different product cycles and levels of competition, plus technological work varies by the type of industrial market where the IT work is performed. IT workers most commonly can be found in three major industrial markets: vendor, consulting and application industries (National Research Council, 2001). Of the three, the application industry represents the most highly dense concentration of IT workers.

The vendor industry includes a few large, and many small, companies that create, develop and market both custom and packaged software. It is further characterized by frequent spin-offs and mergers, where companies tend to buy other companies for their patented technology and skilled workforce. This industry is characterized by high levels of product innovation and short product cycles, making the vendor market prone to high levels of competition. Part of the competitiveness in this industry relates to the vendors' abilities to respond to changes in customer needs and part relates to the low start-up costs. In addition, these organizations tend to be young and lack the human resource experiences of more seasoned employers.

Employees in the vendor industry tend to be highly educated, holding degrees beyond the bachelor's level. They work comparatively long hours to attain competitive salaries. These long work hours and lack of employer experience with human resources suggest that family-friendly policies probably are not yet well developed or widely practiced within this industry. We would expect women in this situation to have some difficulty juggling conflicting priorities between work and family, since they are more likely than men to seek ways to customize their work schedules by going from full-time to part-time employment, sharing jobs with other women in similar positions or subcontracting (Meiksins & Whalley, 2002). The industrial characteristics of vendors, therefore, tend to present men with more opportunities for better work-related outcomes than women. Perhaps this accounts for the comparatively few professional IT women working in the vendor industry.

Unlike the vendor industry, the consulting industry consists of highly diversified companies that analyze, recommend and assist end users of IT regarding the most efficient and effective hardware/software vis-à-vis a business strategy. Companies range from those that specialize solely in IT to those that consult on a range of services, including marketing, accounting, finance and IT systems. Due to the breadth of services provided within this industry, companies range in size from single-individual consultants to large multi-national firms and range in maturity with human resource practices and policies. Female participation in the consulting industry is likely to range in correlation with human resource policies.

In the IT consulting industry, travel is often required as part of the workload. As women struggle to juggle work and family commitments, they often avoid employment opportunities that require extensive time away from home (Meiksins & Whalley, 2002). Consequently, we expect this reasoning will account for some of the under representation of women in the IT consulting industry.

The application industry is comprised mostly of mature companies that use packaged software adapted to a specific service or product. In this situation, the IT is not the end product of the companies, but it is fashioned to enhance delivery of the final product. The majority of IT professionals working in the application settings work in banking and finance, insurance, health care and, increasingly, material applications. Compared to the vendor industry, the application industry tends to be relatively stable. The companies tend to employ large numbers of people, and therefore, they are obligated to obey federal employment laws and regulations. As a result, companies within the application industry tend to have established human resource practices and policies, which often include family-friendly policies. Accordingly, many professional IT women might well seek employment in the application industry due to these "female-friendly" policies.

Organization of the Workplace

The organization of the workplace reflects the division of labor among workers and how their work efforts are coordinated towards common objectives. Accordingly, the distribution of formal organizational power, work schedules, relations among co-workers and between workers and management, training opportunities and compensation systems potentially can impact differences between men's and women's work-related outcomes.

Most large or well-established organizations, such as those in the IT application industry, are characterized by a hierarchy of promotional paths that define the skill sets required to hold a position, and the levels of skills needed for advancement. These paths represent levels of authority as well as internal labor markets. As workers demonstrate levels of skill and responsibility critical to the central objectives of the organization, they advance upward on the promotional ladder. Men, however, hold more than half of the managerial positions in the U.S. (Tomaskovic-Devey, Knoke, & Spaeth, 1996). In fact, the gender of a supervisor makes a significant difference in advancement opportunities of women, their personnel evaluations and initial earnings (Reskin & McBrier, 2000). Hence, a gendered pattern emerges where typically masculine jobs offer higher monetary rewards and embody more power inside the organization than typical feminine jobs within the same industrial sector (Kanter, 1977; Cockburn, 1991). The result is gender segregation in the workplace.

Because organizations in the vendor industry must be flexible and responsive to customers' needs, the organizational structure itself must be more streamlined where responsibility is distributed, rather than centralized throughout the organization. Often referred to as high-performance work systems, these workplaces differ from the more traditional bureaucratic workplaces by including flexible technologies, team-centered cooperative work arrangements, classification of workers by skill rather than by rigid job titles and knowledge sharing (Godard, 2001; Appelbaum, Bailey, & Berg, 2000; Rogers, 2001).

Compensation systems, too, reflect the organization of work. In the high-performance vendor industry, for example, compensation is based on performance rather than time spent at work. Personal wages in this situation approach the higher end of the range for IT workers. The compensation system in the IT application industry is more traditionally based on standard forms of evaluation, such as grade level and hours worked. Because it is more common for men to be at a higher level than women within an IT application environment, men tend to be compensated significantly more than women. Hence, women seeking careers in professional IT-related fields would find more opportunities and better rewards in the vendor and consulting industries, but they are likely to find fewer family-friendly employers in those industries.

Familial Structures

As an institution, the family has extensive influence shaping the career aspirations and work orientations of individuals. Characteristics of the immediate family are known to influence job satisfaction, willingness and ability to work extended hours or travel for business purposes, and ability to cope with job-related stress (Carlson & Perrewe, 1999; Thomas & Ganster, 1995). Key family characteristics include marital status, children under the age of 18, employment status and occupation of partner and the status of health among family members. Importantly, men and women differ significantly in terms of responsibility for integrating familial and work commitments (Moen, 2003; Presser, 2003).

They also differ in terms of their personal adjustments to integrating work and family. Men often experience work and family dissonance when they work longer hours than their spouses, are involved in an unstable marriage or perceive an inequitable distribution of household labor. Women, on the other hand, report work/family imbalance when they are in an unhappy marriage or when young children are present in the home (Hochschild, 1997; Presser, 2003).

Since occupational pathways overlap with family trajectories for men and women throughout their lifetimes, marital and parental statuses are often robust predictors of employment and earnings for women and men. Women are considerably more likely than men to make employment sacrifices, such as choosing to have a job as opposed to a career. These sacrifices have consequences for women's work hours, advancements and incomes. Consequently, career development and work-related outcomes are more directly influenced by family status for women than for men, though some professional IT men have opted for a reduced work schedule in order to better attend family responsibilities (Meiksins & Whalley, 2002). For some observers of the IT workforce and the information economy in general, computing is seen as enabling a more accommodating work schedule for family responsibilities (Rifkin, 1995), but the evidence is not uniformly conclusive (Wajcman, 2004).

CONCLUSION

The institutional perspective offers a more comprehensive view of women's and men's career paths in IT when compared to human capital, essentialist differences, social constructionist and techno-feminist conceptions. All but the human capital perspective suggest women in IT face an unlevel playing field independent of intent, skill or ambition. In doing so, however, the relationships among career intent, skill, ambition and gender are not made theoretically problematic in relation to IT work and the contexts in which that work occurs. In contrast, the institutional perspective acknowledges the problematic nature of one's life course as it unfolds over time in relation to contextual changes, thereby accounting for how this process shapes differences in career development for men and women. Effectively, the institutional perspective concentrates attention on the interactions of various institutional influences that produce gendered work-related outcomes.

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KEY TERMS

Essentialist Perspective: Men and women have innate differences that lead to gendered outcomes. Thus, men's and women's take-up and uses of computing differ based on biological differences.

Human Capital Perspective: There is a cost-benefit analysis for investing in skill enhancement: The more skills a person has, the more valuable they are to employers. Competence is the singular measure of value.

Institutional Perspective: People's actions are guided and changed by social contexts. The family, industrial markets, work organization and education are among the basic institutions.

Life Course: The pattern of interactions people experience within various institutional contexts are social actions. Life courses are temporal, path dependent and marked by events.

Social Constructionist Perspective: Men and women are socialized by distinct social influences that ultimately lead to more valuable work-related outcomes for men than women. Thus, men and women learn through socialization to act differently towards IT.

STEM: Science, technology, engineering and mathematics. Educational degrees seen by the U.S. Department of Education and the National Science

Foundation as those that prepare scientists and engineers.

Techno-Feminist Perspective: IT historically has been a masculine project. For women to successfully engage in IT work, they must abandon some degree of their femininity to better understand IT's masculine language and implementation.

ENDNOTES

[1] Evidence makes clear that women generally obtain lower levels of work-related outcomes because of their "second-shift" responsibilities as primary child-bearers and care takers. To be sure, numerous employers across the U.S. IT landscape have acknowledged the value of practices that enable workers, especially women, to balance responsibilities between family and work, but barriers for the utilization of relevant polices too frequently limit the opportunities to take advantage of the practices (Frankel, 1998; Thompson et al., 1999).

[2] Central to these questions remains a concern about who controls and has access to the advances in technology. While masculinity has been historically represented in technologies more than femininity, certain groups of women have gained influence and prestige by the relationships with men who control the advancement and implementation of new technologies.

Fostering Technology Interest Among High School Girls

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INTRODUCTION

This article describes a pilot program that uses a holistic approach to address the multitude of barriers girls face when considering a career in the information technology (IT) field. Girls with Engineering Mindz (GEMz) is a highly structured technology program developed to encourage female high school students to embrace technology while strengthening their academic, personal, and social development. GEMz is not just a program for girls to develop technical skills. The premise of the GEMz program is to attract and maintain its participants by developing multiple components of the "whole" person. The GEMz program was designed to attract its participants to the IT industry through a three-prong strategy: develop technical skills in a societal framework, enhance basic life skills, and promote positive self-images. The name GEMz was selected to promote enthusiasm and collaboration among program participants. Teams are given the names of precious gems, (e.g., Diamonds, Rubies, etc.) to symbolize their positive self-worth as valuable contributors to both technology and their communities.

BACKGROUND

During the past two decades, numerous researchers have reported on the dissipating ratio and the shrinking pipeline of women in IT (Camp, 1997; Frenkel, 1990; O'Lander, 1996). According to the National Center for Education Statistics, in the 1983-1984 academic years, 37.1% of the bachelor degrees in IT were awarded to women. Unfortunately, 19 years later, for the 2002-2003 academic years, women were only awarded 27.0% of the bachelor degrees in IT, a 10.1% decrease.

The under-representation of women in IT is a downward, spiraling cycle, a self-perpetuating phenomenon. Consider the research literature and develop a scenario of a female high school student who is an excellent problem-solver, a logical thinker, and someone who enjoys working with both computers and people. The student is considering her aspirations to attend college and contemplating her major. According to Teague (2000), many girls do not view computer science as a viable career option. Rowell et al. (2003) found "… enjoyment and interest have been shown to be a major reason students select a career … " (p. 54). They reported that males were 17.0% more likely to have an interest in computer programming. Weinberger's (2004) research indicated that many girls did not choose IT as a major because they did not think the courses would be interesting. Girls may have the misconception that the primary career in IT is a programmer who sits alone in a room hacking at a computer all day with little opportunity to interface with other people (Beyer, Rynes, & Haller, 2004; Margolis & Fisher, 2002). Furthermore, during their formative years, girls tend to not have the same "magnetic attraction" to computers that some of their male counterparts do (Margolis & Fisher, 2002). Girls usually do not consider themselves "hackers" or "computer geeks," and due to social gender stereotyping, the computer has been labeled as a "boy's activity" (Kiesler, Sproull, & Eccles, 1985; Margolis & Fisher, 2002;

Moorman & Johnson, 2003; Pearl et al., 1990; Shashaani, 1994). Girls who are interested in the IT field are so outnumbered that there is an intense "sense of isolation" (Frenkel, 1990). As if this sense of isolation were not enough, the boy's magnetic attraction to computers and societal biases help to perpetuate the expectation of students, parents, and educators that "boys and men, not girls and women will excel in and enjoy computing" (Margolis & Fisher, 2002, p. 16). Consequently, the current computer culture is alienating and uncomfortable for girls and women (Frenkel, 1990; Kiesler et al., 1985; Pearl et al., 1990).

How can girls become more knowledgeable and comfortable with the IT industry? Unfortunately, Jepson & Perl (2002) noted, "school counselors typically have very little basic information on the IT industry…" (p. 37). Furthermore, one of the most cited research issues regarding understanding the IT industry is that while girls usually have first-hand knowledge of female doctors, lawyers, and teachers, girls do not have sufficient female IT mentors and role models (Cohoon, 2002; Klawe & Leveson, 1995; Moorman & Johnson, 2003; Spertus, 1991; Townsend, 2002). Additionally, researchers have reported that some women feel significantly less confident than men in their computer ability (Beyer et al., 2004; Margolis & Fisher, 2002; Shashaani, 1994; Teague, 2002). Considering the possibility of the cumulative effect of these interest barriers, it is no wonder that girls lack a career interest in the IT field. The female high school student who is contemplating a major decides not to pursue a career in IT and the cycle continues …

PROGRAM MODEL

Girls with Engineering Mindz (GEMz) is a highly structured technology program developed to foster IT interest by developing numerous components of the whole person. The GEMz program is based on a holistic approach, designed to attract young women to the IT industry by combining strategies suggested by previous research. These strategies include: foster overall computer usage (Shashaani, 1994); develop technical skills in a societal framework (Margolis & Fisher, 2002); dispel the geek misperception (Beyer et al., 2004; Margolis & Fisher, 2002; Pearl et al., 1990); build self-confidence (Beyer et al., 2004; Teague, 2002); and expose GEMz participants to female IT role models (Cohoon, 2002; Klawe & Leveson, 1995; Moorman & Johnson, 2003; Spertus, 1991; Townsend, 2002).

The primary goal of the program is to inspire female students to use, experiment with, and feel comfortable with computers. GEMz is designed to portray the IT industry as both a human and a technical discipline. The focus is to encourage female high school students to improve their technical skills through utilizing computer technology for a purpose: the betterment of their communities and society as a whole. GEMz supports the ideology that numerous activities in the IT industry involve working on teams and not just sitting alone in a room hacking at a computer all day. The majority of IT jobs include a combination of individual and team activities. Therefore, it is essential for GEMz participants to enhance their skills through personal contribution and team collaboration. This concept of team is expanded to community, as GEMz participants broaden their sense of social responsibility through involvement in a community service activity. Female IT role models are utilized to help support and encourage young women and serve as living examples of successful women in the IT industry. Interacting and obtaining guidance from successful role models helps enhance the self-confidence of GEMz participants. It also provides positive evidence and imagery to enable them to recognize and visualize their full potential.

PROGRAM IMPLEMENTATION

The GEMz program implementation structure employs a three-tiered, holistic approach to attract high school girls to the IT industry. The tiers are: Tier I—Develop Technical Skills in a Societal Framework; Tier II—Enhance Basic Life skills; Tier III—Promote Positive Self-image and Encourage Social Interaction. All activities in the GEMz technology program seek to provide young women with a well-rounded exposure to IT, community, team-building, and self-development. The following sections describe the specific tactics executed to implement the three-tiered, holistic approach.

Tier I: Develop Technical Skills in a Societal Framework

The GEMz 2002 program was titled "Promoting Community Organizations." Teams created fictitious community service organizations, established missions, budgets, and structures, then designed and developed Web sites to promote their organizations. Agency services ranged from extreme sport outings for inner city youth to teen pregnancy prevention programs. A female professor from DePaul University's School of Computer Science, Telecommunications and Information Systems (CTI) and a female CTI graduate student taught FrontPage 2000 as the Web site development tool. Teams were also taught SWiSH 2.0, a Flash animation software package. The teams accessed various online sources to create their banners and logos. In addition, they used JavaScript forms to develop an interactive portion for their Web sites.

The GEMz 2003 program was titled "Chicago Alderman Election." GEMz participants designed the information requirements to support a political campaign for a fictitious Chicago alderman and implemented a database application. A female DePaul CTI faculty member and a female DePaul PhD student guided GEMz participants on how to design and implement a database using Access software. In addition to the database application, a DePaul graduate alumna led the teams in a multi-media component of the camp, where the GEMz teams designed, filmed, and edited a 30-second campaign commercial using Premiere software.

The GEMz 2004 program was "Promoting Community-Based Organizations through Digital Cinema." That year, three of the six counselors were former GEMz participants. This new feature of the program incorporated two additional benefits: (1) it allowed the program managers to continue to mentor prior GEMz participants who had taken on additional leadership responsibilities as camp counselors; and (2) the counselors earned money that could be used for college expenses. Each team was asked to unite their creative and technical talents to produce a digital film for one of six Lawndale Christian Development Corporation (LCDC) outreach programs. LCDC is a community-based organization established in 1987 by Lawndale Community Church to bring revitalization to the lives and environment of Chicago's Lawndale residents through economic empowerment, housing improvements, educational enrichments, and community advocacy. Over the course of six days, GEMz participants learned the documentary production process and were taught how to shoot and edit a 3- to 5-minute documentary through the utilization of iMovie, a movie editor software package.

Tier II: Enhance Basic Life Skills

Along with daily technology instruction, GEMz teams participated in personal development workshops. Participants attended Money Management and Public Speaking workshops, competed in team challenge activities, attended a conflict resolution session, and participated in a community service project. The objective of the money management workshop was to guide the teams through a high-level overview of the categories required for their organizational budgets. The teams were instructed to consider both start-up and ongoing expenses. Teams were also encouraged to brainstorm and document the revenue portion of their business endeavors. The Public Speaking workshop was created to prepare GEMz participants for the formal presentation of their project that occurred at the end of camp. Specific techniques were presented on how to organize presentations and strengthen oral communication skills. DePaul University's Team Challenge workshop consisted of a series of physically and intellectually challenging, competitive activities designed to assist the teams to build trust amongst team members, develop greater communication skills, and enhance collaborative problem-solving skills. Immediately following the team challenge activities, debriefing sessions were conducted to allow team members to evaluate their interactions. GEMz participants also attended a Conflict Resolution session to further develop their interpersonal and team skills. This session equipped GEMz participants with a variety of tools and techniques to help them resolve conflicts that might arise in their intra/inter team activities throughout the week.

Tier III: Promote Positive Self-Images and Encourage Social Interaction

Each evening, GEMz participants engaged in social development workshops. These workshops promoted positive self-image and social interaction. Activities included movies, sports, self-defense, African and Salsa dance, Holistic Me, and Reflections. In the Holistic Me workshop, the speaker discussed the multi-dimensional aspects of a person. During this workshop the participants were instructed to value their whole being, while emphasizing their individual self-worth and value. The speaker acknowledged that it was important for GEMz participants to look beyond their physical characteristics and be cognitive of their mind, their heart, their character, and their soul. For this reason the workshop was named, "Holistic Me—my mind, my body, and my soul. Who am I?" During the Reflection sessions, GEMz participants were allowed time to quietly reflect on their camp experience and record them in personal journals. They were also encouraged to share their thoughts with the group to further stimulate social interaction. GEMz participants broadened their sense of social responsibility through participation in a community service activity. For two consecutive years, GEMz participants assisted the staff of Boulevard Arts Center in a landscaping beautification project. The community service activity gave them the opportunity to see themselves not only as an individual, or as a member of a team, but also as a valued contributor to their community. To further promote inclusion, GEMz participants were continuously exposed to female IT professionals. Program managers, counselors, and speakers were all women who held numerous IT positions including chief information officers, IT directors, network engineers, IT consultants, IT project managers, IT professors, and IT undergraduate and graduate students.

RESULTS

The three summer GEMz programs described here were developed by merging several of the previously stated strategies. The programs explored the potential value of using a holistic approach to interest high school girls in the IT field. Evaluation forms were administered at the end of each camp. The objective questions on the evaluation form used a 5-point Likert scale. GEMz participants indicated that they agreed or strongly agreed that 90.6%, 94.0%, and 100.0% of the workshops and activities were interesting for the 2002, 2003, and 2004 programs, respectively (Table 1). We also know that GEMz is effective in stimulating the interest of some girls in the IT field. Although most GEMz participants have not yet completed high school, three young women have applied to CTI as a direct result of attending the GEMz program.

The majority of open-ended survey responses were also positive, and reflected the holistic nature of the program, as can be seen in the representative comments in Table 2.

Table 1. Overall participant evaluations

Program year	Number of participants	Evaluation return rate	No. of high schools	% of activities rated interesting
2002	27	92.6%	8	90.6%
2003	42	88.1%	25	94.0%
2004	36	72.2%	20	100.0%

Table 2. Representative open-ended responses

Tier I (Technical Skills) comments:
I learned how to use FrontPage and make a web site. That was new to me.
The most beneficial aspect of the day was lab time because I learned a lot of info about Access database.
Filming and editing the documentary. It was very fun and interesting and it gave me some ideas on what I might do in college and when I graduate from college.
Tier II (Basic Life Skills) comments:
The Money Management workshop made me realize the importance of budgeting.
Getting a chance to speak in front of everybody was a nice experience.
Tier III (Positive self-images and social interaction) comments:
The Self-Esteem class was very interesting and I learned a lot about society with the statistics that the teacher gave us. It talked about other teenage girls like me and how they felt about themselves.
I really appreciate being here. I learned a lot of things about myself and I also learned how to make myself a better person and how to react to challenging things…
The most beneficial aspect of the day was conflict resolution, which was four ways to solve the conflict. Listen, understand, respect, and resolve.

FUTURE TRENDS

Originally, the GEMz program was established by four female IT graduate students who yearned to interact with more female colleagues. The program now helps high school girls recognize the societal context of IT, while at the same time helping to develop their minds, hearts, and souls. This holistic approach is perhaps the greatest contribution of the GEMz program. It is possible that the long-term key to expanding the role of women in technology lies with the nature of the holistic approach pioneered by GEMz. As GEMz alumni move from high school through college, they will be tracked to determine if their interest in IT continues. While the actual number of girls affected by the GEMz program is relatively small, the potential impact of the program in demonstrating the viability of the holistic approach is vast.

CONCLUSION

Various barriers have been identified and possible solutions have been recommended to break the self-perpetuating cycle of low female interest in IT. Some barriers seem simplistic, with relatively straightforward resolutions, (e.g., tell girls about true attributes of the IT industry). Others exist in the very essence of our current societal norm and require extensive social change, (e.g., educators must learn to understand gender stereotypes in computing and create a bias-free environment). This article only addressed a minute segment of the under-representation issues in the IT industry. For example, retention issues were not addressed, nor were minorities or people with disabilities. IT stakeholders must continue to develop and evaluate a comprehensive collection of intervention strategies to create a truly diverse IT environment. The GEMz program has demonstrated that those strategies should include a holistic approach that addresses the multiple dimensions of people's lives.

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KEY TERMS

Basic Life Skills: General skills that can be useful across numerous professions or in every day life, (e.g., money management, team building, effective oral and written communication, and conflict resolution).

Career Interest Barriers: Actual or perceived factors that discourage an individual from choosing a specific career.

Female IT Role Models: Women in the profession who are successful in the IT field and willing to mentor others. It is essential for these role models to be visible to young women who are deciding upon a career path in IT.

Geeks and Hackers: Margolis and Fisher (2002) describe these individuals as " … in love with computers, myopically focused on them to the neglect of all else, living and breathing the world of computers … " (p. 65). The major difference in the term hacker relative to geek is a hacker also means a person who gains unauthorized access to other computers.

Holistic Approach: A broad strategy designed to integrate multiple aspects of a topic. In the GEMz program, the holistic approach was a program design strategy created to address multiple aspects of the participants whole being; their minds, hearts, bodies, and souls.

Shrinking Pipeline: Tracy Camp (1997) describes the shrinking pipeline condition as "the ratio of women involved in computer science from high school to graduate school has been dwindling at a startling pace ... " (p. 103).

Technical Skills in a Societal Framework: A focus on technical skills as they relate to solving or enhancing a community issue.

Funding Women in Science, Engineering, and Technology in Ireland

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INTRODUCTION

In the mid-1990s, I was one of a number of women who recognised the importance of having an on-campus child-care facility for staff and students at the University of Limerick.[1] Up until our child-care facility, Silver Apples, opened in November 1999, we had no on-campus child care available to us. The facility opening was due mainly to the efforts of a small group of women who used many opportunities to talk to management about the issue we had. As a direct result of this lobbying, the University of Limerick applied for and received funding; this would partly fund the building of the facility. More recently, the facility's management, in conjunction with our local primary school (first level), opened a purpose-built after-school club, the first of its kind in Ireland.

This anecdote is an indicator of how Irish society saw the need for child care 10 years ago: It was not high on the political, educational, or business agenda. During local elections at this time, I spoke with politicians about the issue of child care. Many of them had not come across this as an issue previously, or else they chose to ignore it.

Things have changed! One of the current hot political topics in Ireland is the provision of child care to all sectors of employees. It is discussed in the media and in political circles. Questions are being asked as to how this will be funded: whether working parents can claim tax allowances or the government will make direct payments to the facilities providing child care. This change in attitude has come about not solely because of lobbying, but also because the demand for child-care provision in Ireland has grown significantly. In recent years, the workforce demographic has changed. Women are staying in or returning to the workforce, and this is being encouraged at the highest levels within our government. The changing child-care situation is an indicator of this.

In Ireland, the economy performed very well throughout the 1990s. This improving economy has given an opportunity to women to return to the workforce. In 1990, less than 36% of women aged 15 and over were employed; in 2004, this statistic increased to 45% (Central Statistics Office, http://www.cso.ie). Women return to the workplace after becoming mothers and so take maternity leaves and/or parental leaves, which may be as short as 4 months and as long as 2 years. Furthermore, women who broke their career paths to become full-time parents, which may have extended to 20 years, are also returning to work.

BACKGROUND

Women working in science, engineering, and technology (SET) may experience difficulties in returning to a workplace where the nature of their jobs has changed significantly, even in a short number of years. Furthermore, young women are not taking up SET third-level options. For example, at the University of Limerick, less than 10% of engineering students are women. Internationally, people (mainly women) currently in SET careers have shown concern about these two issues, and in many countries, networks have been set up to promote SET careers to women. These networks provide initiatives to promote SET choices that are available to both groups of women: those returning to SET careers and those considering SET careers. It is not a case of requiring all women to take SET options: We do not want to see square pegs in round holes. What is required is that women are given choices and can make those choices freely.

In Ireland, once such network is Women in Technology and Science (WITS). WITS was inaugurated in November 1990 to actively promote women in technology and science in Ireland. It does this through running initiatives such as role-model days and mentoring, and until recently, it was often a requirement for volunteers to organise and run such initiatives. However, that too is changing. The Irish government is recognising the value of retaining and retraining talented people. Consequently, initiatives have been instigated to support women returning to work. Some of these initiatives focus on actions, like the provision of child care, others on sectors, for example, women in rural areas and women in disadvantaged areas. What we are interested in are those initiatives that focus on SET.

Initiatives at the National Level

Recent women-in-SET initiatives include some funded by Science Foundation Ireland (SFI) through the National Development Plan (NDP) Equality for Women Measure.

National Development Plan: Equality for Women Measure

The NDP is a major development plan involving an investment of 52 billion euro of public, private, and European Union funds during 2000 to 2006. Covering investments in many aspects of the development of our economy, there is a specific requirement for gender mainstreaming throughout the plan. In addition, as a support to gender mainstreaming, the Equality for Women Measure is a positive-action program that complements this. Through this measure, 70 organisations have been funded to undertake positive-action projects for women. The specific objectives are as follows:

- Improve women's access to education, training, and employment
- Achieve equality for women in the workplace and in business
- Increase the number of women participating in decision making (Department of Justice, Equality and Law Reform, 2003)

While much of the funding from the Equality for Women Measure did not go specifically toward science, engineering, and technology projects, many women who are pursuing careers in these areas benefited. Furthermore, some projects were SET focused. Through this funding, WITS (2005) was enabled to produce a directory of SET women who are qualified for and available to sit on state boards. Tallaght Institute of Technology have instigated a mentoring program, Mentorlink.ie (2005), for young women in SET. Funding from this initiative has given the opportunity to the University of Limerick and the Limerick Institute of Technology to jointly run a foundation course in science, engineering, and technology for women. This course is discussed in detail later.

Science Foundation Ireland

Science Foundation Ireland is a statutory body that administers Ireland's Technology Foresight Fund. Through an investment fund of 646 million euro (2000-2006), it provides financial support for research in biotechnology and information and communications technology. SFI is interested in promoting cooperation between education, government, and industry in these two research disciplines.

Recently, Science Foundation Ireland announced a fund for the promotion of research among women. It states, "SFI's Objective is to encourage and participate in the development of sustainable mechanisms and practices which will ensure that women have an equal opportunity to compete on the basis of their scientific expertise, knowledge and potential" (http://www.sfi.ie). It has provided planning grants to 11 third-level institutions (universities and institutes of technology), giving them an opportunity to assess "women's participation in science and engineering research activities and research management." Following this planning period, SFI will be funding up to three development grants in 2006, each worth up to 250,000 euro, allowing third-level institutions to implement "long-term sustainable initiatives" for such participation. In the University of Limerick, due to the receipt of a planning grant, we interviewed faculty and postdoctoral and postgraduate researchers to investigate what positive actions for women's SET development can be taken within our institution.

In addition, SFI has announced Principal Investigator Career Advancement Awards that are designed to support people, particularly women, who have broken their careers for parental or caring responsibilities. This funding for individuals is worth up to 200,000 euro per year for 3 or 4 years, and allows for part-time as well as full-time research.

Foundation Course in Science, Engineering, and Technology for Women

A joint initiative run by two third-level institutions, the University of Limerick and Limerick Institute of Technology, is a certificate in foundation studies in science, engineering, and technology for women. This course was originally run during academic year 1999 to 2000, and due to its success and funding received from the Irish government's National Development Plan Equality for Women Measure, it is continued to be made available. This initiative in third-level access was targeted at women aged 22 and over who were unable to avail of third-level education through the traditional routes for a variety of reasons. The provision of a third-level foundation course is a central plank of the strategy for improving access to third-level education for the targeted group, and students who successfully complete this course are able to progress through the certificate, diploma, or degree route in courses at either third-level institution. The foundation course was designed and developed by an ad hoc working group consisting of four women and one man drawn from key departments in both institutions. Depending on resources, we aim to take 16 to 20 students annually.

The aims of the course are the following:

- To introduce students to a third-level environment
- To equip students with requisite knowledge for moving into third-level education
- To equip students with skills that help to further their knowledge
- To build up students' confidence in their ability
- To expose students to the basics of science and technology

Motivation of Staff

The staff members involved in this initiative volunteered to sit on the course design team. This was done in addition to their normal teaching, research, and administrative duties. What was the motivation for taking on this extra work? The staff members themselves recognise the importance of giving mature female students opportunities that are not available otherwise. We had seen the success of similar courses in other institutions such as Galway Mayo Institute of Technology and Tallaght Institute of Technology. One staff member had personal contact with a woman who had grasped at this opportunity for second-chance education and was in the process of completing a third-level degree. All of the team members work in institutions that have minimal numbers of women employed in our disciplines. The women on the team have experience of the opportunities that our predecessors—women who have been our role models—have given to us and believe it is important to offer similar opportunities to others.

Academic Course Structure

As with any course design, there were many discussions as to what modules should be provided and at what level. The approved course consisted of the subjects listed in Table 1 split over two 10-week semesters.

The foundation course is 1 academic year in duration. In the autumn semester, students are exposed to foundation courses in science and technology, and also provided with transferable skills such as study and project-presentation skills. Dur-

Table 1. Academic course structure

Term 1	Term 2
Science Foundation Course 1	Science Foundation Course 2
Introduction to Information Technology	Introduction to Electronics and Computing
Foundation Mathematics 1	Foundation Mathematics 2
Communication Skills	Foundation Course Project

ing the second semester, students study these subjects in more depth. They undertake a group project. This provides them with an opportunity to assimilate what they have already learned into an area in which they have a specific interest. Underlying both semesters are a communications and career-guidance stream and a mathematics stream. Evaluation of performance is by the assessment of projects and by formal examinations scheduled as for traditional students.

Nonacademic Course Structure

The course is time-tabled for 4 days each week, with Friday left free for mentoring meetings with study advisors, project work, and private study time. In order to facilitate women who have family commitments, including dropping off and picking up their children from school, classes run from 10:00 to 2:00 daily. Each student has a mentor who is a member of the course team and is available to meet students regularly. A life-skills module, dealing with issues such as time management, exam techniques, stress management, and relaxation, is also made available to the students.

Lecturers on the course were facilitated to consider how teaching adults would be different from teaching traditional students. They were made aware of boundary setting and of the counseling service available to the students.

Management

The course leader is a permanent member of the faculty at the University of Limerick. The course board consists of the manager, a member of the Department of Adult and Continuing Education at the University of Limerick, the course leader (chair), and representatives from the Limerick Institute of Technology and from various University of Limerick departments. Lecturers in the course are employed from the approved pool of staff at both institutions.

Progression from the Foundation Course in SET

Upon completion, students are expected to be confident about progressing directly into one of the institutions in order to embark on a longer term course. Successful candidates have an enhanced opportunity to experience third-level education, and the majority of students proceed into mainstream certificate, diploma, and degree programs in one of the participating third-level institutions. This route gives the student the option to break down their further education into stages. They can obtain a certificate after 2 years, a diploma after 3 years, and a degree after 4 years. This gives them progressive options and therefore can be more attractive to mature students as it is not as daunting of an undertaking as a 4-year commitment. When they apply for mainstream courses in each of the institutes, their successful participation in the foundation course is taken into account.

Since the course began, 60 women have completed it successfully. There has been a dropout rate of 15% of those who commence the course. The number progressing to third-level mainstream education justified the running of the foundation course. During this time, approximately 60% of students have commenced studies within third-level institutions, and a further 30% have commenced either full-time or part-time employment. Furthermore, some students have completed their third-level education and have graduated with certificates and degrees such as a certificate in business computing, BSc in business computing, BSc in environmental science, and BSc in industrial chemistry. It is also notable that the majority of graduates from the foundation course go on to become honours graduates from their third-level courses.

Based on the progress of the students who have completed the course, we are satisfied with the way the course ran. There are some considerations that we continue to keep in mind.

- It is important for students to be able to attend the course on campus, particularly in light of the aim of students continuing into third-level education.
- Research into the effectiveness of this and other similar programs is needed.
- The level of computing skills can be disparate.
- Facilities in the third-level institutes, particularly for science, are overadequate. For example, we would have liked to use a combined physics-chemistry laboratory, which is common in second-level schools in Ireland, but only

had separate third-level physics and chemistry laboratories available in the third-level institutions.

Other successes noted were the following:

- The spirit within the class and the feedback from the students was positive and encouraging.
- As a joint venture between two institutes, it was successful.
- On a personal level, staff enjoyed the opportunity for collaboration.

The importance of the communications and career-guidance stream should not be underestimated, particularly with a course such as this one. We were dealing with students who mainly either had not been in the workforce for many years or had not had the opportunity for further education. As well as providing scientific and technical knowledge, it was seen as important to give them support and advice in their career development. This was given during various discussions on the following topics:

- Job market
- Subject matter of possible courses
- Available options including ab initio degrees and the certificate, diploma, and degree routes
- Completion of college application forms

As stated by one of the external examiners, this was "a very worthwhile course which seems to have been well received by the students." Some of the students have gone into related further studies, thus indicating the success of the course.

FUTURE TRENDS

Ireland's child-care issue demonstrates visibly that women want to be given the opportunity to return to work. Because of the availability of funding from the National Development Plan and Science Foundation Ireland, we have the opportunity to make the return to science, engineering, and technology more attractive and available. Unlike what has been previously available, there is now funding available for those of us already involved in SET to promote SET careers to other women, thus offering choices to them that did not always exist in the past. The expectation is that the number of women pursuing SET careers in Ireland will increase.

CONCLUSION

Now that funding is being provided by the government, we should not forget the women who have given voluntary time—from weeks to years—to promote SET to women who would otherwise not have been made aware of available options, nor should we forget those women who brought SET issues to the political agenda. Funding is becoming more available, and within SET, I look forward to women having that choice, being involved in decision making, and becoming more involved in shaping our technological society.

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KEY TERMS

Ab Initio Degree Course: Students enroll in a course of study for 3 or 4 years, and if they attain the required standard, they are awarded a bachelor's degree. They do not have the option of receiving other awards during their course of study.

Certificate, Diploma, and Degree Courses: Students enroll in a certificate course, and if they attain the required standard, they can then enroll in a diploma course. If they attain the required standard for their diploma course, they can then register for a bachelor's degree course. Each course takes 1 to 2 years and gives students an option to break down their further education into stages.

Direct Payments: Situation in which the government gives a child-care facility payments toward the cost of running the facility.

Equality for Women Measure: An initiative in Ireland run by the Department of Justice, Equality and Law Reform under the National Development Plan and supported by the European Union. It supports projects specifically focused on improving opportunities for women in Ireland. Gender mainstreaming is one of the objectives of the Equality for Women Measure. (http://www.ewm.ie)

Honours Graduates: In Europe, students may get bachelor's degrees at the honours level, which indicates that they have reached a specific standard in their degree course.

Tax Payments: Situation in which revenue commissioners give a tax credit to an individual who is paying for the cost of child care.

Third-Level Access: Providing the opportunity for people to participate in third-level education.

ENDNOTE

[1] In Ireland, child care is paid for by the parents of the children and is normally organised privately. There are very few government-run or subsidised facilities available to parents.

Gender and Chat Forums

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INTRODUCTION

Within the last decade, the Internet has become one of the fastest growing technologies. According to research conducted by the Pew Internet and American Life Project, nearly 60% of the United States (U.S.) population is now online, with variation based on race, age, education, region and income (Spooner, 2003). Despite the persistent discrepancies in access, Internet usage among the U.S. population is steadily increasing, up by 9% since 2000. Throughout the 1990s, well-educated white men primarily populated the Internet; however, this situation has changed in the last 5 years. As of 2000, women made up 50% of Internet users and "Hispanics [were] just as likely to be online as whites, and African Americans are coming online at accelerating rates" (Horrigan, 2000, p. 2). Overall, the Pew study found that activities such as e-mail (and other online communication forums); online shopping; Web surfing; connectivity with family and friends; hobbies; news; and information are popular online uses. Through the Pew Institute's many studies, it is clear the Internet is a key aspect of social life in U.S. culture.

BACKGROUND

A particularly popular online activity is chatting. A variety of chat forums are in existence, including multi-user domains (MUDs), Internet relay chat (IRC) and Web chat. The very first form of chat was IRC; it was designed to allow a large number of people from different locations to chat among themselves. The initial protocol of IRC was designed in Finland by Jarkko Oikarinen in 1988, and since then, it has spread to more than 60 countries worldwide. Chat rooms such as IRC house a form of computer-mediated communication (CMC) or interaction that occurs in "real time: All participants in an interaction must be electronically present at the same time, and messages are immediately transmitted through the intermediate servers to all participants, wherever they may be" (Paolillo, 1999, p. 3). Chat rooms are constant and channels (specific chat rooms) are occupied 24 hours a day. Web chat rooms are differentiated from other chat forums by their multimedia character. They incorporate typed messages, voice communications, emotional cues (emoticons) and, sometimes, video streams.

GENDER AND CHAT FORUMS

Many studies explore the role of gender in chat forums (Armentor, 2005; Sunden, 2002; Kendall, 2002; White, 2001; Ignacio, 2000; Parks, 1999; Yates, 1997; Roberts, 1999; Herring, 1999; Soukup, 1999; Danet, 1998; Rodino, 1997; Turkle, 1995). Table 1 offers a list of key findings on the issue. Most research on the relationship between gender and chat forums focuses on the issue of identity.

Rodino (1997) found in her study of IRC that gender is more of a performance than a binary category. Furthermore, she found gender construction is not divorced from *real* life, but is allowed to be multiple. Findings demonstrate that for some, gender "is made to be more 'real' than it really is" and for others "gender's performativity is rendered more 'virtual' than it really is" (Rodino, 1997, p. 18).

For her research on MUDs, Kendall (2002) conducted an ethnographic study that addressed issues of gender identity. Based on her findings that demonstrated participants often reproduced hegemonic versions of masculinity, Kendall (2002) argues that "online relations do not occur in a cultural vacuum. However much people may desire to leave behind the constraints of their off-line cultural backgrounds and social identities, their social interactions online remain grounded in understandings and contexts that intersect with off-line real identities" (Kendall, 2002, p. 225). Armentor (2005) found in her research of a Web chat forum that there were many more performances of dominant gender identities than there were acts of transgressive identities. However, she also demonstrates that for many participants, the Web chat forum is a space for them to experiment and play with sexual identity. She notes that for some female chatters, this may be especially appealing. During cybersex, one can perform versions of sexuality without the dangers of face-to-face relations.

On the topic of gender harassment in synchronous and asynchronous forums, Herring (1999) used a linguistic approach to analyze talk from each forum. She found that in both forums, the rhetorical gender dynamics were the same. That is, she observed that online gender harassment followed a certain sequence, which included: "(non)provocation, harassment, resistance, escalation, compliance" (Herring, 1999, p. 164). Herring, Johnson and DiBenedetto (1995) explored the claim that "men dominate computer-mediated interaction much as they dominate face-to-face interaction: by 'talking' more, by taking an authoritative stance in public discourse, and by verbally harassing and intimidating women into accommodation or silence" (Herring et al., 1995, p. 67). They found these forms of interaction were common in two mixed-sex discussion groups. However, they observed women participating in resistance strategies. Armentor (2005) found striking examples of discursive gender harassment and homophobia in the Web chat room she studied. However, she also noted that there were many instances of discursive resistance to gendered dynamics. Some participants who were the target of discursive oppression resisted through reframing issues and fighting back with words.

FUTURE TRENDS

The complexities of online social life are only beginning to be understood by researchers. As Internet research continues to grow and explore these complexities, new findings are constantly surfacing. A variety of chat rooms are in existence, used for a variety of purposes. Within these virtual communities, regular participants establish their own set of norms. However, flaming (an attacking message) is often a problem for many virtual communities, especially chat communities. In addition, some chat rooms are clogged with bots (software robots that simulate human chatters) that attempt to lure chatters into Internet pay porn sites (Armentor, 2005). However, chat spaces may also offer participants a common meeting ground and the possibility of meeting new people without the fear of physical harm (Armentor, 2005).

CONCLUSION

Chat forums are simulated hangouts or places to go when people are looking to meet new people with similar interests. They are not separated from the off-line world. They are places and spaces very much connected to off-line social life and structures, especially when it comes to gender, sexuality, race and ethnicity. Chat forums also offer many new opportunities for resisting these structures and forming new types of communities. As the Internet continues to expand throughout society and as more research is conducted, new questions arise about how network spaces, such as chat forums, contribute to everyday social life.

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Table 1. Key issues on gender and chat forums

The reproduction of gendered identities
Breaking out of gender binaries
The reproduction of oppressive social interactions (i.e., sexist, homophobic or racist messages)
Resistance to gender harassment and other forms of harassment
Experimentation in sexuality and sexual identity among participants.

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KEY TERMS

Chat: Real-time communication between two users via computer. Once a chat has been initiated, either user can enter text by typing on the keyboard, and the entered text will appear on the other user's monitor. Most networks and online services offer a chat feature.

Chat Room: A virtual room where a chat session takes place. Technically, a chat room is really a channel, but the term *room* is used to promote the chat metaphor.

Cyberspace: A metaphor for describing the non-physical terrain created by computer systems. Online systems, for example, create a cyberspace within which people can communicate with one another (via e-mail), do research or simply window shop. Like physical space, cyberspace contains *objects* (files, mail messages, graphics, etc.) and different modes of transportation and delivery. Unlike real space, though, exploring cyberspace does not require any physical movement other than pressing keys on a keyboard or moving a mouse.

Emoticon: Short for *emot*ion *icon*, a small icon composed of keyboard characters and used in e-mails and instant messaging that indicates the mood and/or emotion of the writer. Because of the nature of written text, which doesn't rely on vocal inflection and facial cues to communicate attitudes such as sarcasm and humor, the writer's tone is often not apparent. Emoticons, when read sideways, mimic facial expressions and, therefore, relay the emotion behind an expression.

Fasgrolia: The name for the fast-growing language of abbreviations, initialisms and acronyms.

Flame: A searing e-mail, newsgroup, or chat message in which the writer attacks another participant in overly harsh, and often personal, terms.

IM: Short for *i*nstant *m*essage, a type of communications service that enables you to create a kind of private chat room with another individual to communicate in real time over the Internet, analagous to a telephone conversation but using text-based, not voice-based, communication. Typically, the instant messaging system alerts you whenever somebody on your private list is online. You can then initiate a chat session with that particular individual.

Lurk: To eavesdrop on a chat room. In most online areas, lurking is perfectly acceptable behavior and is, in fact, encouraged so that you get the feel of the area before posting your own comments.

Netiquette: Contraction of Internet etiquette, the etiquette guidelines for posting messages to online services and, particularly, Internet newsgroups. Netiquette covers not only rules to maintain civility in discussions (i.e., avoiding flames), but also special guidelines unique to the electronic nature of forum messages. For example, netiquette advises users to use simple formats because complex formatting may not appear correctly for all readers. In most cases, netiquette is enforced by fellow users who will vociferously object if you break a rule of netiquette.

World Wide Web: A system of Internet servers that support specially formatted documents. The documents are formatted in a markup language called HTML (*HyperText Markup Language*) that supports links to other documents, as well as graphics, audio and video files. This means you can jump from one document to another simply by clicking on hot spots. Not all Internet servers are part of the World Wide Web.

Gender and Computing at University in the UK

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INTRODUCTION

In the late 1970s, women's progress and participation in the more traditional scientific and technical fields, such as physics and engineering, was slow, prompting many feminist commentators to conclude that these areas had developed a near-unshakeable masculine bias. Although clearly rooted in the domains of science and technology, the advent of the computer was initially seen to challenge this perspective. It was a novel kind of artefact, a machine that was the subject of its own newly created field: "computer science" (Poster, 1990, p. 147). The fact that it was not quite subsumed within either of its parent realms led commentators to argue that computer science was also somewhat ambiguously positioned in relation to their identity as masculine. As such, it was claimed that its future trajectory as equally masculine could not be assumed, and the field of computing might offer fewer obstacles and more opportunities for women than they had experienced before. Early predictions of how women's role in relation to information technology would develop were consequently often highly optimistic in tone. Computing was hailed as "sex-blind and colour-blind" (Williams, Cited in Griffths 1988, p. 145; see also Zientara, 1987) in support of a belief that women would freely enter the educational field, and subsequently the profession, as the 1980s advanced.

During this decade, however, it became increasingly difficult to deny that this optimism was misplaced. The numbers of females undertaking undergraduate courses in the computer sciences stabilised at just over a fifth of each cohort through the 1980s and 1990s, and they were less likely to take them in the more prestigious or research-based universities (Woodfield, 2000).

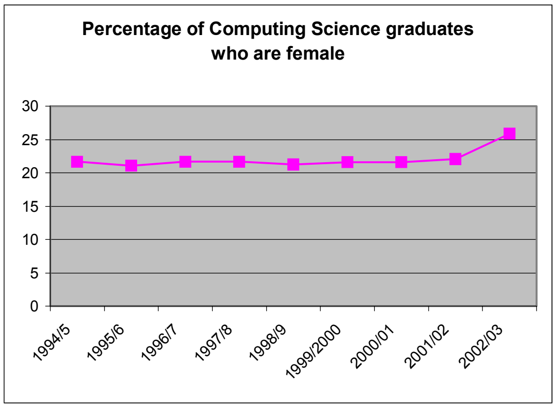
Tracy Camp's landmark article "The Incredible Shrinking Pipeline" (1997), using data up to 1994, plotted the fall-off of women in computer science between one educational level and the next in the US. It noted that "a critical point" was the drop-off before bachelor-level study—critical because the loss of women was dramatic, but also because a degree in computer science is often seen as one of the best preparatory qualifications for working within a professional IT role[1]. The main aim of this article is to examine how the situation has developed since 1994, and within the UK context. It will also consider its potential underlying causes, and possible routes to improvement.

BACKGROUND

In the UK, throughout the 1990s and into the new millennium, the achievements of secondary school-age girls (11-16 years) progressed significantly in the more traditional scientific and technical subjects, and began surpassing those of boys. Before an age when some curriculum choice is permitted (14 years old), girls perform better in science. Furthermore, although fewer of them take science once they have choice, they continue to surpass boys' achievements in the area. Higher proportions of girls now gain an A-C grade pass in their GCSE examinations in chemistry and biology and physics (Department of Trade & Industry (hereafter DTI), 2005; Equal Opportunities Commission (hereafter EOC, 2004)). In terms of A levels, the qualifications usually taken at the end of the first two-year period of non-compulsory education (16-18 years), girls also proportionately achieve more A-C passes in these subjects (EOC, 2004).

Achievements in computing courses have followed this trend. Over the last decade, girls have gained around 40% of GCSE qualifications in computer studies, and they are now more far likely to gain an A-C pass than their male counterparts (EOC, 1994-2004). Nevertheless, at A level, when students traditionally specialise in three or four subjects, the trend has been for the majority of girls

Figure 1.



Note. Based on original analysis of Higher Education Statistics Agency data provided under ad hoc data enquiry: 23148

to opt out of computing. In 1993, in England, girls only accounted for 13% of students deciding to further their computing education to A level standard in England (EOC, 1994). By 2003, this picture had significantly improved, with girls comprising 26% of those studying computing or information technology A level (Joint Council for Qualifications, 2004). Although this still represents a substantial "leak" between one educational level and its successor, it is noteworthy that girls have recently become proportionately more likely to gain the top grades in these qualifications as well (DTI 2005; Joint Council for Qualifications, 2004).

COMPUTER SCIENCE AT THE HIGHER EDUCATION LEVEL[2]

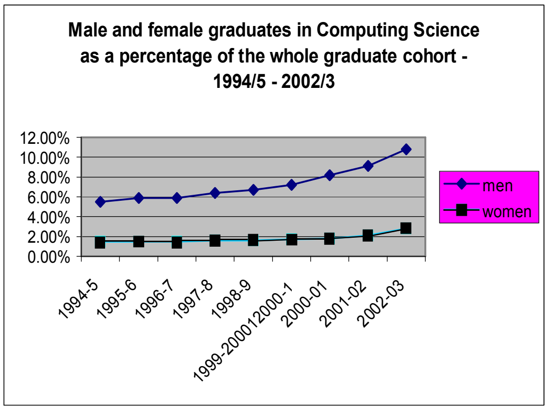
As Figure 1 indicates, the proportion of women within computer science courses at tertiary levels remained fairly static between 1994-2003, despite the improving proportion of them taking computer science at A Level over the same period. Although there appears to be a slight increase between 2002 and 2003, this is likely to be due to changes in the way graduate statistics in the UK were calculated between these two years[3]. On average, women comprised 22% of those completing a degree in the area over the period.

In the UK, female applicants to computer science courses differ in key respects from their male counterparts. They are especially likely to cite their interest in the subject as the main reason for studying it and are committed to finding the right course above other considerations, such as location of university and so forth (Connor, Burton, Pearson, Pollard, & Regan, 1999; Craig, Galpin, Paradis, & Turner, 2002b; Millar & Jagger, 2001). This interest would seem to be intrinsic, as they are less likely to cite future employment prospects as a motivating factor for their subject choice than their male counterparts (Millar & Jagger, 2001). Female computer science applicants have indicated that, in order to aid course choice, they review a wide range of information and are especially influenced by the information provided in university prospectuses and by experiences of pre-entry campus visits. Indeed, information deriving from universities is deemed far more helpful than advice from secondary school teachers and careers advisers (Connor et al., 1999; Craig et al., 2002b; Millar & Jagger, 2001).

Women are slightly more likely to be accepted for a degree within the broad area of mathematical sciences and Informatics, of which computer science is a subset, probably due to their better success rates at A-levels. They are also more likely to complete their degrees (DTI, 2005).

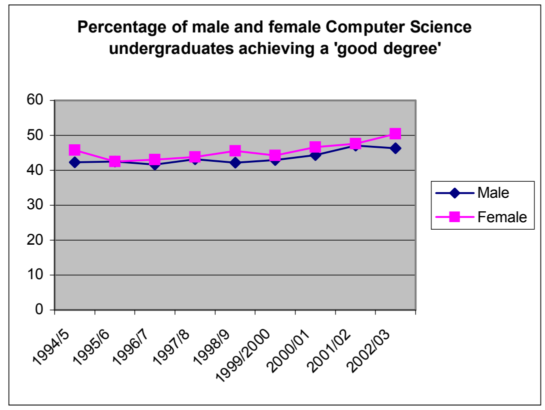
Once on their degree courses, although they are now over-represented within higher education as a whole (comprising 56% of new graduates), as Figure 1 has illustrated, women remain significantly outnumbered within each cohort of computer science undergraduates. This is in a context where computer science is attracting more undergraduates year-on-year whereas physics, chemistry, and engineering are attracting fewer, and mathematical sciences broadly the same numbers (DTI, 2005). As Figure 2 chronicles, between 1994/5-2002/3 the numbers of men and women completing degrees in this area in the UK climbed throughout the period, with the percentage of men climbing slightly faster than the percentage of women. In 1995, 5.5% of all male graduates qualified in computer sciences, as against only 1.5% of all females. By 2003, 11.8% of males were graduating in this area, as against 2.8% of females. While there are grounds for optimism insofar as the proportionate increases during this period for women were comparable to those of men,

Figure 2.



Note. Based on original analysis of Higher Education Statistics Agency data provided under ad hoc data enquiry: 23148

Figure 3.



Note. Based on original analysis of Higher Education Statistics Agency data provided under ad hoc data enquiry: 23148

it remains of concern that while more than a tenth of male graduates take their degrees in this area, less than 3% of females do. This is significant in the context of the link between computer science and professional-level IT work, and the critical role computer science knowledge plays in our society more generally.

Women are also generally under-represented among the academic faculty of computer science at university, although their numbers in Lecturer (28%) and Researcher (30%) ranks remains better than we might expect given their undergraduate representation (DTI, 2005). They are, however, disproportionately underrepresented in the more senior academic ranks (DTI, 2005).

Interestingly, however, as Figure 3 shows, of those taking degrees in this area, women fare no worse than men in terms of classification achieved, and their performance would seem to be improving. In 1994/5, 9.6% of men achieved the top grade of degree—a First Class—as opposed to 7.6% of women. By 2003, however, 11.9% of men were achieving this grade against 11.6% of men. Furthermore, women have also been marginally, but consistently, more likely to obtain a "good" degree—a First Class *or* Upper Second—than men since 1994, and by 2003 just over 50% of them achieved this standard as against just under 47% of men.

FUTURE TRENDS AND CONCLUSION

Once this picture is digested, we can see that there are some grounds for cautious optimism about the future: an increase in female participation at A level; improvements in female performance in relation to both pre-university and university qualifications; and evidence of above-average interest in computer science on the part of female undergraduates. Notwithstanding these changes, a key question is begged, however, given the context of the overall increase in the importance of the subject: Why is the under-representation of women that established itself in the field in the 1980s and 1990s not correcting itself more quickly?

It is still claimed by some that women are naturally less predisposed than their male counterparts to be attracted to, or to perform well within, the sciences in general (McCrum, 1996) and computer science in particular (Craig et al., 2002b). This position, however, is increasingly difficult to sustain in the light of changes in female participation and performance rates in educational computing, and the fact that there are significant local variations in the uptake and experience of university-level computer science courses (Cahoon, 2001; Craig et al., 2002b; Millar & Jagger, 2001). As

Cahoon has suggested, it is much more likely that social factors are at play to explain female under-representation as "women can and do succeed in Computer Science when conditions do not deter them" (2001, p. 1).

These "social factors" would seem from the evidence to fall under two main areas. First, females, including female computer science undergraduates, project a far more negative image of IT work than males. As their educational choices are so closely bound up with their projected career trajectories (EOC, 2001; Miller, Neathey, Pollard, & Hill, 2004), it is reasonable to assume that this tendency has impacted on female recruitment levels to the subject at university. Secondly, female experiences of computer science degrees would seem to be less positive than those of their male counterparts, and it is very likely that the stories of such experiences become part of the information young women draw on when making their decisions about what subjects to study at university.

To take the first point, the available evidence suggests that women taking computer science degrees, and courses that might prepare them for undergraduate study, are generally not likely to be fully aware of the benefits of a career in IT (Millar & Jagger, 2001; Peters, Lane, Rees, & Samuels, 2003), while simultaneously being more likely to be alive to its real and perceived disadvantages. They are more likely to project, for instance, that it will be solitary work, when they, as a group, have a preference for team-based and socially-embedded computing (Craig et al., 2002b). The problems facing them should they opt for a career in computing cannot be ignored, substantial as they are. Female computer science graduates are less likely than males to find employment at the end of their degrees, despite their tendency to have achieved a higher degree classification, and to be better educated more generally. Once in employment, they are likely to receive less pay for comparable work, and many describe a working ethos that systematically privileges men over women (Millar & Jagger, 2001; Woodfield, 2000). In a context where female educational achievements are outstripping those of males at every level of education in the UK, and female work aspirations are becoming increasingly clear and uncompromising, it is almost certainly the case that the negative perception of IT work plays a critical role in determining the numbers of women choosing courses that qualify them for it. As Millar and Jagger have claimed, problems appear in the relationship between women and the computer sciences "once women begin to structure their education towards a career" (2001, p. A-iv). There are substantial benefits to IT work, however, that could be clarified and communicated to those selecting their GCSE, A level and university courses: salary levels, notwithstanding the gender gap, tend to be higher than average; existing female IT professionals rarely describe themselves as bored or unfulfilled in terms of the work *per se*. More fundamentally than the need to communicate these benfits, the sector needs to consolidate the beneficial aspects of IT careers for women, and work to eradicate the more negative aspects.

The earlier communication about the advantages of IT work takes place, the better. It is claimed that educational choices, based on projected career costs and benefits, are already taking place when UK teenagers face their first opportunity to specialise, around age 14. This is also an age when young males and females are most sensitive to gender-appropriate and gender-inappropriate career choices. It is of concern then, that there seems to be so few reports of positive representations of professional IT work as a viable career goal for girls (and their parents) by teachers or careers advisers within secondary schools, and that the provision of female-friendly spaces for computing is still considered cutting edge (Craig et al., 2002b; Millar & Jagger, 2001; Peters et al., 2003). Improvements in the knowledge, and sometimes the attitude, of adults playing a key role in pre-university course choices, could make a significant difference to female participation rates at this level.

As well as the role played by the image of IT work, the reported experiences of those undertaking a computer science degree must also partially account for the level of female participation at university. There is a wealth of evidence to suggest that female students' under-representation on courses creates its own problems in terms of their confidence, adjustment, enjoyment, and achievement levels. They report themselves to feel pressurised to adapt to a male-dominated and male-oriented educational regime in order to survive (see, for example: Bjorkman, Christoff, Palm, & Vallin, 1998; Blum, 2001; Margolis & Fisher, 2002; Peters et al., 2003).

Evidence from those institutions that have attempted to make significant changes within their computer science programmes so that women will feel less alienated suggests that the have enjoyed far greater female participation and approval rates as a result (Connor et al., 1999; Margolis & Fisher, 2002; Millar & Jagger, 2001). In doing so, they point to a wish list of best practices for others interested in doing the same. These include building a curriculum that assumes a minimal level of previous IT experience, providing mentoring systems and female-friendly learning spaces, and ensuring that faculty are sensitive to the needs and abilities of female students (Blum, 2001; Cahoon, 2001; Hefce 2002; Margolis & Fisher, 2002). One course in the UK, where such considerations have been central for some time, reports high rates of female uptake of degree places, but also that 100% of women on the course maintained a desire to become an IT professional after the completion of their degree (Craig et al., 2002).

The finding that women are heavily reliant on the information provided in prospectuses is heartening in this regard. It confirms that there is a clear window of opportunity for the more progressive universities through which they can encourage potential applicants and reduce reliance on general anecdotal or impressionistic information that may not apply to their courses. If more institutions embraced the same ethos, a critical mass of women entering computer science undergraduate programmes could be achieved in the next decade. This, in turn, could impact significantly on the general culture of educational computing and beyond into the workplace, which could lead to improvements in the sector's image. The beneficiaries of this would not just be the women who would otherwise have turned away from the subject at degree level, but also the UK economy and society which is arguably at present drawing its computing scientists and skilled IT professionals from an artificially restricted pool.

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KEY TERMS

Classification of Degree: UK degrees are ascribed "classifications" that usually correspond to the following percentage results (averaged over all assessments contributing to the final grade):

First – 70%+
Upper Second or 2:1 – 60-70%
Lower Second or 2:2 – 50-60%
Third – 40-50%
Pass – 30-40% (a bachelor degree without honours)

Equal Opportunities Commission/EOC: The Equal Opportunities Commission is an independent, non-departmental public body, funded primarily by the government. It provides free research reports and statistics chronicling the position of women and men in all aspects of UK life, including work and education. Web address: http://www.eoc.org.uk

GCE A Level: The General Certificate of Education, A level (Advanced Level) is usually taken 2 years after GCSEs and as a non-compulsory, pre-entry qualification for University-level Study. Students usually take 3 or 4 specialised subjects at this level, which they are free to select.

GCSE: The General Certificate of Secondary Education is usually taken by 15-16 year olds in a range of subjects—some compulsory (English, maths, and science) and some optional (including Computer Studies)—at the end of their compulsory schooling. Achieving 5 GCSE grades A-C is considered the desirable educational benchmark to be reached by this age.

Good Degree: A term used in academic literature and common parlance to indicate a degree which has been classified as an "Upper Second" or "First," (i.e., in the top two degree classifications. It is normally assumed that those going on to post-graduate study will have such a degree, and they are preferred in many employment contexts.

HESA (Higher Educational Statistics Agency): HESA was set up in 1993 by the UK Government to act as a central source for higher education statistics and has become a respected point of reference. Web address: http://www.hesa.ac.uk.

IT/Computer Professional: An individual working within the IT/computer sector within a complex and skilled role that is classified within the category "Professional occupations" (e.g., software engineers), or sometimes within "Associate professional and technical occupations" (e.g., computer programmers)—in the National Statistics classifications, Standard Occupational Classification Codes (2004): http://www.statistics.gov.uk

ENDNOTES

1 Elsewhere, degrees in mathematical sciences and/or business and administration degrees are included in analyses of gender representation within degrees associated with IT and IT employment (see, for instance, Millar & Jagger, 2001). Here, unless stated otherwise, I will be using the narrower group of "computer science" degrees, defined, according to Higher Educational Statistics Agency programme categories as including: computer science, information systems, software engineering, artificial intelligence, and other programmes within computer science.

2 All of the statistics included within this section are based on original analysis of Higher Education Statistics Agency data provided under *ad hoc data enquiry: 23148*.

3 HESA changed its discipline classification scheme between the years 2001/2 and 2002/3, making comparisons between pre-2002/3 data and post-2002/3 data problematic.

Gender and Differences in Online Teaching Styles

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INTRODUCTION

Researchers interested in the role gender plays in the educational environment have investigated differences in the teaching styles of men and women in the face-to-face classroom (Caplan, 1994; Clegg, Trayhurn, & Johnson, 2000; Proost, Elen, & Lowyck, 1997; Statham, Richardson, & Cook, 1991; Sullivan, 1999). In distance education, the differences between the teaching styles of men and women are similar to those noted in the face-to-face classroom (Barrett, 2004; Dupin-Bryant, 2004). In both educational settings, men and women prefer different teaching styles. In the face-to-face classroom, differences in the teaching styles of male and female faculty members have depicted women as leaning more towards a learner-centered style than men, even though men and women are exposed to similar experiences in their own educational endeavors (Moulton, 1992; Scotney, 1986; Statham et al., 1991; Stickney-Taylor & Sasse, 1990). The purpose of this discussion is to use research on teaching styles to provide more information about the online environment for those who will be teaching, learning, or administrating online distance education.

BACKGROUND

Teaching styles have been defined in numerous ways. The following background sections lay a foundation for exploring teaching styles. The first section provides a general overview and definitions of teaching style followed by a brief section focused on the recent direction of online distance education. The subsequent section highlights gender theories with a focus on communication and decision-making. These areas are the main framework for understanding gender differences in online teaching styles.

Defining Teaching Styles

Teaching styles have been explored in a variety of ways. Grasha (1996) used categories to explore teachings. He offered five distinct teaching styles including Expert, Formal Authority, Personal Model, Facilitator, and Delegator. Conti (1978) created a continuum with a learner-centered style on one end and a teacher-centered style on the other. In order to highlight the details of teaching style, Conti used the continuum to develop seven factors: (1) learner-centered activities, (2) personalizing instruction, (3) relating to experience, (4) assessing student needs, (5) climate building, (6) participation in the learning process, and (7) flexibility for personal development. Each of these factors is also measured on the learner-centered to teacher-centered continuum.

Although Conti's Principles of Adult Learning Scale (PALS) was originally designed to describe teaching styles in the face-to-face environment, it has been researched and applied in numerous environments including the online environment. For the purposes of this discussion, Conti's PALS frames the differences in teaching styles based on gender.

Conti (1985a) defines teaching styles as a set of behaviors that are consistent regardless of the setting or course being taught. Numerous studies have validated this definition by demonstrating the consistency of teaching styles from setting to setting (Chanchaem, 2001; Totin Meyer, 2002). Although various researchers and theorists have defined teaching style as an instructor's set of behaviors that are consistent from setting to setting and from course to course, an instructor's teaching style falls within a range.

In the face-to-face classroom setting, Conti defined the learner-centered style as a "method of instruction in which authority for curriculum formatting is jointly shared by the learner and practitioner"

(Conti, 1985a, p. 7). He referred to the teacher-centered style as one where the instructor takes the majority of the responsibility for directing the learning environment. Others have characterized a teacher-centered style as one where instructors implement more traditional teaching techniques in an effort to transmit knowledge to the learners (Jarvis, 1995).

Educators over the years have argued the superiority of teaching styles. More recently, the argument has focused on *when* a particular teaching style is most useful (Miglietti & Strange, 1998). Although an occasional researcher has argued that one teaching style is the most effective including for the online environment (DiBiase, 2000), others have noted that an effective teaching style varies based on the content, the learners and the environment (Miglietti & Strange, 1998). Other researchers have compared the two environments and investigated the impact on teaching style when an instructor transfers a face-to-face course to the online environment. In such an instance, Chanchaem (2001) found no significant difference in the teaching styles of those who moved to an online environment.

Even though a variety of teaching styles are desirable, Conti's research along with that of a few others (Conti, 1985b; Miglietti & Strange, 1998; Post, Carusetta, Maher, & Macintosh, 1998) makes a viable argument for a teaching style that favors a learner-centered style because of more positive learning outcomes in classrooms where instructors implement such a style. In the community college arena, O'Banion (1997) has promoted the learning college which focuses on learner-centered activities as the most effective environment for meeting students' need for an education that is accessible anytime, any place, and any way. Regardless, no single teaching style meets the needs of all learning styles; each has its advantages and disadvantages. Exploring issues related to online distance education will further enhance this discussion on gender differences and teaching styles.

Online Distance Education

Online distance education, which has its roots in correspondence courses and has a long history of providing alternative access to education, has changed drastically over the past decade. Some institutions entered online distance education by encouraging faculty to move their correspondence courses to the Web. This mindset perpetuated the notion that students are empty vessels to be filled with the wisdom of an expert either through books or through some form of textual means of connecting with the content. As such, this notion would dictate a more teacher centered-style.

Educators and observers of the educational environment have often assumed that technology would alter the learning environment. Early studies of educational technology determined that the delivery method did not play a key role in altering the learning environment. Russell's (1999) No Significant Difference studies make the point that there is little difference between the face-to-face classroom and the online environment. Consequently, a learner may find the online educational environment similar to the face-to-face environment. The similarities may be greater now considering the history of online distance education.

Less than 10 years ago faculty were learning html and designing Web sites as a way to offer their courses online. At that time, the process for offering a course in the online environment was very tedious. Faculty often resorted to merely loading their notes to a Web site and calling it an online course. For students, interaction with the other learners and the instructor was limited as was interaction with the content.

Today, faculty members are using learning management systems (LMS) as a means of posting course materials and conducting activities on the Web. Some of the more popular LMS include Blackboard, WebCT, Desire2Learn, and Angel. The benefit of using an LMS is that faculty members do not have to learn a special language and the systems are designed to effectively facilitate the management of online courses. Additionally, the tools available in LMS can be used to create a more engaging and interactive environment including blogging features, wikis, discussion boards, survey tools, and testing functions. Through the use of these tools faculty are able to create a more engaging learning environment where students can discuss the content and collaborate on projects along with participating in numerous other activities.

Unlike the face-to-face environment, the online environment requires more preparation and planning. In the face-to-face environment, faculty can work from an outline, whereas in the online environment, faculty must identify, select, design, develop, and generally prepare materials ahead of time to address the topics on the outline. With the necessity of preparing in advance, faculty members have the opportunity to reduce the impact of their other roles including that of gender on their teaching styles. It also allows time to provide a variety of activities that will meet the needs of students' various learning styles and fit with a particular teaching style. The next section explains how gender theory is a background for understanding how gender relates to teaching styles.

Gender Theories

Gender communication theories provide a foundation for understanding differences in online teaching styles. On a very basic level, communication is at the heart of teaching. Consequently the differences in communication appear to parallel the differences found between teaching styles. Furthermore, the primacy of a gender role supersedes that of a secondary role such as that of being an instructor in the online environment. A brief review of gender communication and decision-making theories highlight some of the possible differences related to teaching styles.

Research (Belenky, Clinchy, Goldberger, & Tarule, 1986; Gilligan, 1982) showed that men and women differ significantly in the ways they communicate. Men on the average take on a role in communicating with others that can be characterized as an expert. Additionally, men are more likely to look at the overall picture and identify with an authoritarian role. Women, on the other hand, are more likely to prefer the role of a consultant while focusing on details and collaborating with others.

In very general terms, women tend towards a more collaborative manner of communicating emphasizing polite exchanges. They share examples from their personal experiences and strive to connect with the previous experiences of learners. Women are often more comfortable as a guide or a facilitator in the learning environment. Men tend to focus on creating status differentials. They are more comfortable functioning as the expert, the one in charge who possesses knowledge and expertise the students need to acquire.

The primary difference between the communication and decision-making styles of men and women centers on the ways in which they view and structure relationships. Men approach relationships as hierarchical structures where as women view them as networks (Gilligan, 1982). Decisions women make related to relationships are often influenced by a conflict between selfishness and sacrifice (Belenky et al., 1986; Gilligan, 1982). Men are more influenced by competing rights. Consequently, men address issues from a more abstract perspective and women take a more personal stance. (Gilligan, 1982). Differences in the ways men and women communicate and make decisions appears to carry over into their teaching style. Men's hierarchical approach to relationships lends itself to a teacher-centered style and women's network approach is most compatible with a learner-centered teaching style.

Although communication patterns vary by the context of a situation, regardless of gender, men employ a communication style that is more forceful, direct, and commanding than women who tend to communicate more politely, indirectly, and personally than men. Whether communication styles vary, they do impact how faulty teach online and what type of teaching style a faculty member adopts.

Gender and Differences in Teaching Styles

Regardless of whether gender is apparent in the online environment, it does play a significant role in the teaching styles that online instructors implement. Gender is not as readily apparent in the online environment because of diminished queues. Faculty members do not always post their photos and they may have a name that makes it difficult to determine their gender. Androgynous names such as Chris, Alex, and Lou, make it difficult to determine gender. Faculty members have the opportunity to "hide" behind the computer. Inhibitions related to gender role may also be reduced because visual feedback from students is not present. These notions contribute to the assumption that differences in teaching styles do not exist.

When the gender of the instructor is known, learners may form more specific expectations for teaching styles based on the instructor's gender.

Table 1. Differences in the teaching styles of women and men

Women	Men
Interpersonally oriented	Technically oriented
Allow students voices to be heard	Authoritarian
Actively engage students in learning	Socratic questioning
Cooperation and collaboration	Competition
Democratic discussion	Lecturing
Share personal information	Use examples from the text or others
Bridge students' experiences with their own	Abstract style
Listen to personal problems	Espouse information to students

Even if gender is not known, understanding a little about teaching styles may provide a basis for determining what a faculty's teaching style is and selecting learning strategies for a successful experience in the online environment. The best situation is one in which faculty share their teaching style with the learners so they have a better understanding of what to expect.

Research on teaching styles in the online environment is limited. Results of one study (Barrett, 2004) depicted differences in the online teaching styles of male and female community college instructors. Women demonstrated a more learner-centered teaching style than men in terms of their overall teaching style. Table 1 highlights the overall differences in teaching styles between women and men. The differences in activities and behaviors between genders show the ways in which faculty interact with students and the type of learning environments they create.

In the same study (Barrett, 2004), differences in teaching style were also apparent based on Personalizing Instruction, in which case, women were more likely than men to implement a more learner-centered teaching style based on this one factor in Conti's teaching style continuum. Differences in Personalizing Instruction demonstrated that women are more likely than men to exhibit some of the following behaviors:

- Use different teaching techniques and different materials for different students
- Let students work at their own pace
- Match instructional objectives to outcomes, abilities, and needs of the learners
- Encourage competition

When compared to communication theories, the differences in teaching styles are particularly interesting especially in the area of encouraging competition. In terms of teaching style, women tend to encourage competition, which is a male characteristic in communication styles. Differences may be attributable to the way male and female faculty use competition. To illustrate, women may use competition to bring teams of students together whereas as men may use competition as a way of creating status differentials. Although gender is not an absolute in predicting teaching styles, it may be a clue towards understanding them. The following section considers future trends and issues related to teaching styles.

FUTURE TRENDS

The future of online teaching styles will be similar to those styles that have been noted in other educational environments and differences between the teaching styles of men and women will persist in the online environment. Thus, Conti's definition of teaching style as a set of behaviors that is consistent from setting to setting will continue to hold true.

What has the potential to change in terms of online teaching styles is the instructional design process. As faculty members are developing online education, assessing teaching style is often omitted from the instructional design process. The focus of analysis in designing instruction centers on the characteristics and needs of the learners and issues surrounding the learning environment. These are essential areas of emphasis for an effective analysis, but those who are moving through an instructional design process should include an analysis of teaching style. Teaching styles is important because it has an impact on the learning environment and it affects the ways students learn. Instructors can provide information about their teaching style to enhance the success of students, which provides students with the information needed to create more realistic expectations in the online environment.

CONCLUSION

Learners in the online environment should find trends in teaching styles based on gender that reflect the face-to-face environment. Thus, students can expect to experience teaching styles that are similar to those they have previously experienced. As students and faculty move through their experiences in the online learning environment, current trends with teaching styles will most likely persist. Overall, assessing and understanding teaching styles provides faculty with a better understanding of their online teaching. For students, this information offers the opportunity to create realistic expectations so that students may receive the greatest benefit from their online educational experiences.

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KEY TERMS

G

Blogging: Online journaling where readers can read text, view photos, listen to audio files, and comment on the information posted by an individual.

Discussion Board: A Web-based environment where participants can asynchronously express themselves. Discussion boards consist of three areas. A forum is the top level and it is used similarly to a folder. Within a forum are threads, which are the primary messages. Replies to a thread are called postings.

Learner-Centered Style: A teaching style that focuses on the characteristics, needs, and concerns of the learner.

Learning Management System (LMS): A Web-based program used as a platform for providing course materials and activities. Examples include Blackboard, WebCT, Desire2Learn and Angel.

Online Learning Environment: An educational environment where the emphasis is on learning as opposed to teaching and the educational process uses the Internet as the medium to transmit information and communicate.

Teacher-Centered Style: A teaching style that places the faculty and their issues, concerns and ideas at the center of the learning environment.

Teaching Style: An instructor's perceptions, beliefs, attitudes, and behaviors related to facilitating the learning environment.

Wikis: Web pages where more than one person can easily collaborate to edit a Web page. Often, no special programming skills are needed to edit a Web page and a history is kept which shows who edited the page, what they edited, and when.

Gender and Discourse Styles in CMC Learning Groups

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INTRODUCTION

The evolution of computer-mediated communication (CMC) technologies has brought about changes in the landscape of education. This availability of technologies corresponds with the educational paradigms that are shifting towards the collaborative constructive conceptions of learning (Anderson & Garrison, 1998). To support interaction and cooperative learning among learners, online discussion groups are increasingly being incorporated into the courses of educational institutions.

Educators have deemed interaction as a vital component of collaborative learning (Sutton, 2001), and have provided an important framework comprising four types of interaction: learner-content, learner-instructor, learner-interface, and learner-learner (Hillman, Willis, & Gunawardena, 1994; Moore, 1989). Multiple studies have demonstrated interaction as a critical indicator of positive attitudes towards learning, higher achievement and increased motivation (e.g., Garrison, 1990; Fulford & Zhang, 1993).

If successfully implemented, groupware technologies could support group activities by providing an environment that enables more effective and efficient group communication (Benbunan-Fich & Hiltz, 1999). Benefits associated with collaborative online learning include the availability of time lag which enables learners to reflect on their own perspectives and the opportunity to promote co-construction of knowledge among peers (Bullen, 1998).

In order to facilitate effective construction of knowledge and interaction among learners using the CMC medium, it is critically important for researchers to understand what external factors would influence the interaction styles. In this regard, the current paper takes special note that the study of variations in gender discourse is an important area of research (Gunn, Mcsporran, Macleod, & French, 2003). To date, there has been a growing body of literature which examines the effects of gender on communication styles within an online learning environment. However, the results have been somewhat ambiguous and equivocal across the studies (e.g., Fahy, 2002; Savicki, Kelly, & Lingenfelter, 1996a), suggesting that the binary concept pertaining to gender may not be a useful basis for analysis of communication patterns among learners.

The purpose of this article is to discuss the communication styles of gender and propose a framework which seeks to identify contextual factors that would moderate gender interaction patterns within online learning groups.

BACKGROUND

Communication Styles of Gender

Prior gender-related research conducted in face to face (fTf) settings has indicated distinctions in the interaction patterns of males and females. Studies have revealed that females tend to use interdependent and socio-emotional language and express more non-aggressive behavior. On the other hand, males tend to be associated with task-oriented strategies, expressions of independence and assertions of vertically hierarchical power in their conversational patterns (Duran & Carveth, 1990; Tannen, 1994). In traditional learning environment, research has revealed that the "male learning" style is dominant to the extent that female students speak less in the classroom (Gilligan, 1982).

Analysis of written dialogue discourse in CMC shows that online interaction is a reflection of discourse in fTf mode. Herring (1993), in her analysis of a bulletin board, found differences in language style between men and women. Messages of females tend to be punctuated with "attenuated assertions, apologies, questions, personal orientation, and support", whereas characteristics of male's language include "strong assertions, self-promotion, rhetorical questions, authoritative orientation, challenges, and sarcasm" (p. 7). These findings are further supported by Blum (1998) and Savicki et al. (1996a) in their investigations.

Although the above studies provide evidence for gendered-related discourse styles, results are not consistent. The ethnographic work by Barrett and Lally (1999) revealed that although either gender displayed similar levels of cognitive content, male students exchanged more social content, and wrote longer messages. In contrast, females sent more interaction messages. Fahy (2002) found that despite being in the minority, women posted nearly as many messages as men did. In a study conducted on a graduate level online course, research results indicated that there were no significant differences in gender interaction styles (Wang & Sierra, 2003).

In general, there are two schools of thought concerning gender communication within the CMC medium (Rena & Keith, 2003). The first perspective maintains that CMC will provide a more democratic and egalitarian setting, in effect mitigating gender differences (Rena & Keith, 2003). Text-based CMC, with its loss of socio-contextual cues (Sproull & Kiesler, 1986), removes all cues associated with gender and social class. The second approach focuses on the view that gender differences in communication styles "transcend the medium" (Sussman & Tyson, 2000).

The above discussion implies that gendered-related discourse styles are fluid and elusive (Michaelson & Pohl, 2001). There is thus no compelling evidence to suggest that the communication patterns conform to the dichotomy of female vs. male categories. This further suggests that some accommodation must be made for the contextual specificity (e.g., work vs. school; collaborative task vs. competitive task) when understanding gender similarities and differences, a stance that is in line with the socio-contextual models of gender (Savicki, Kelly, & Lingenfelter, 1996b; Strough & Covatto, 2002).

According to the socio-contextual perspective, gender behavior emerges from the complex interaction between an individual and the contextual settings (Pickard & Strough, 2003; Strough & Covatto, 2002). Prior research studies conducted within the fTf environment indicates the importance of context dependence in gender-related behavior. For instance, females self-disclose more in social context, but males self-disclose more in collaborative context (Shaffer, Pegalis, & Cornell, 1992). Pickard and Strough (2003) found that males and females reported more feminine attributes when working with a partner of another gender than when working with the same gender during a collaborative task.

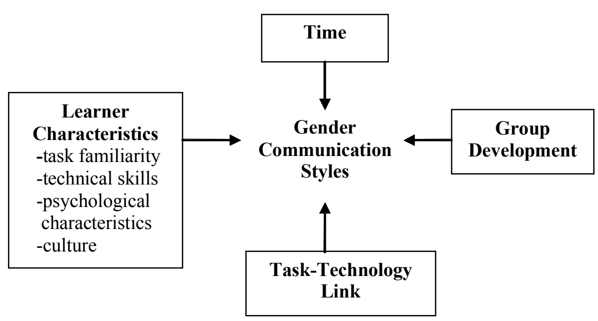
MAIN THRUST OF THE ARTICLE

A Conceptual Framework

As apparent from the preceding discussion, online gender discourse styles might thus be better understood by examining the immediate context (e.g., time) in which the interaction takes place, rather than solely the gender element.

In this section, we put forth a conceptual framework that identifies a set of contextual dimensions which may moderate the discourse patterns of gender in an online setting (see Figure 1). The following deliberates on the individual components of the proposed framework.

Figure 1. A framework of gender communication styles in online groups



Learner Characteristics

Task Familiarity/Technical Skills/ Psychological Characteristics

The individual student brings to the online group discussion a set of abilities and personalities. Prior experiences with CMC and subject expertise have been found to influence online discourse styles. Bielema (1997), in a survey conducted with graduate students distributed across remote sites, found that 28% of the e-mail posts were associated with technical difficulties. As females gained familiarity and confidence with CMC, they developed their linguistic style, in which the discourse shifted from more personal to professional (i.e., informational) (Wyatt, 1993 as cited in Yates, 1997). Sussman and Tyson (2000) found that women initiate discussions more frequently than men, particularly on topics that fall within the female-domain, in which females may have greater expertise (e.g., ballet and skating). Other factors which influence the participation rate include the psychological characteristics of online learners. Learners who experience communication apprehension will refrain from participating in online discussions (Sutton, 2001).

Culture

The culture of a nation can be viewed as the set of norms and values that differentiate populations of different societies (Hofstede, 1980). One of the more conceptually developed (Chang & Lim, 2002) cultural dimension in the literature is the individualism-collectivism aspect. Individualism-collectivism refers to the extent to which a culture fosters its people to promote a group's well-being and to endorse the desires of self over those of a group (Hofstede, 1980). Learners from a collectivistic culture tend to value relationships over task (Chang & Lim, 2002), while those from an individualistic culture are more opinion-oriented and straightforward (Ting-Toomey, 1992). Countries such as the USA are inclined towards the individualistic cultures, while those that lean towards collectivistic culture include most Asian countries, such as Singapore (Hofstede, 1980). Online homogeneously collectivistic groups were reported to exhibit better interaction, social behavior and response than homogeneously individualistic groups (Chang & Lim, 2002).

Previous research has indicated that culture moderates the impact of gender differences (Mortenson, 2002). Prior studies conducted in traditional settings have found that gender stereotypes, such as females valuing social relationships more, apply only to individualistic western countries (e.g., Watkins et al., 1998). A recent experimental study conducted within synchronous CMC settings revealed that there was no significant difference in perceived social presence between female-only and male-only groups, suggesting that previous research which found gender differentiation in communication styles may need more careful discernment (Lim & Lim, 2004). As the subjects involved were Asians, the researchers highlighted the possible moderating role of culture in affecting gender behavior in online settings, such that gender communication differentiation is primarily salient in individualistic, rather than collectivistic, cultures (Lim & Lim, 2004).

Task-Technology Link

Tasks differ in terms of complexity as well as the required interaction style (Benbasat & Lim, 1993; Carabajal, La Pointe, & Gunawardena, 2003). Choice of language is influenced by the task type, as indicated by past research (e.g., Savickiet al., 1996b). McGrath (1984) proposed a circumplex that distinguishes among eight different types of task (see also McGrath & Hollingshead, 1993). The tasks vary in terms of the richness required, in which richness is defined as the extent to which a message is able to carry contextual cues, such as attitudes. The tasks, ordered in terms of increasing information richness required, are planning task, creativity task, intellective task, decision-making task, cognitive conflict task, mixed-motive task, competitive task, and performance task. In the decision-making task, there is no correct solution and group members are required to come to a consensus about the problems. In addition, more information relating to emotions and feelings is required, as compared to an intellective task that has a verifiable correct solution (McGrath & Hollingshead, 1993).

The media richness theory (MRT) (Daft & Lengel, 1986) and social presence theory (Short, Williams, & Christie, 1976) suggest that different communication modes convey different contextual cues. Past research has identified a continuum ranging from e-mail, teleconferencing, videoconferencing, to fTf meetings, where e-mail is touted as the lowest in social presence and fTf communications the richest. The underlying assumption in MRT is that when there is a "fit" between the richness of the media and the equivocality/uncertainity of the task, communication is most effective (Daft & Lengel, 1986).

However, text-based CMC does not entirely lack social contextual cues (Walther, 1992). Studies have shown that users developed an electronic paralanguage to compensate for the missing intimacy cues by encoding these contextual cues in written form (Gunawardena, 1995).

Interaction patterns are affected by the technology type (Chou, 2002); in Chou's study which examined the interaction patterns of learners, findings revealed that there were more support and personal information content in synchronous media than in asynchronous mode. In contrast, the exchanges in the asynchronous CMC constitute mainly opinion and task-oriented information.

Time

The social information processing theory suggests that relational intimacy in computer-supported groups may take a longer time to develop, despite the absence of non-verbal cues (Walther, 1996). This notion was confirmed by Walther and Burgoon (1992), who found that many of the relational dimensions of CMC groups eventually approximated those of fTf over time. Given unconstrained interaction time, high content of social-affective interaction exists in online settings (Parks & Floyd, 1996). However, when faced with perceived time limitations, either gender utilizes the expository style (e.g., flaming), thus reducing the interpersonal content in communication (Fahy, 2002). Prior empirical studies conducted in traditional environments have found time limitations and deadlines imposed to affect the behavior of group members (Druskat & Kayes, 2000).

Group Development

As a group matures, the discourse tends to shift from socio-oriented to task-oriented (Chidambaram & Bostrom, 1997). The time, interaction, and performance (TIP) theory purports that the states of the group change over time, as the group engages in more social oriented or more task oriented activities (McGrath, 1991). Group development research suggests that the initial meetings of newly formed groups are different from other meetings, as members become acquainted with one another (Chidambaram & Bostrom, 1997), whereas well-developed groups are likely to have shared norms for member well-being (Gersick & Hackman, 1990; Chidambaram & Bostrom, 1997). As a group matures, its members are likely to be able to carry out their projects, requiring "less rich information exchanges" (McGrath & Hollingshead, 1993). Newly-formed groups have fewer established norms and will perform more socially related interaction activities (Dennis & Valacich, 1999).

FUTURE TRENDS

This article has developed a framework that can be useful for understanding the discrepancy in findings of gender communication styles. The key to understanding gender differentials in discourse lies in examining situational elements, as proposed by the socio-contextual view (Strough & Covatto, 2002). Despite the importance of interaction in CMC education, there remain a large number of avenues that are yet to be explored in the arena. For instance, to what degree does each identified contextual factor influence the interaction style? How do these interaction patterns affect group dynamics? What specific patterns of interaction style contribute most to learning effectiveness? With these questions addressed, then instructional designers would be able to better incorporate suitable aspects into the design of educational software and thus help enhance online group learning outcomes.

Future researchers could also augment our framework with the social network perspective, which will lead towards a greater understanding of interaction patterns within the CMC medium.

CONCLUSION

Owing largely to the inherent intricacies of group interactions in online discussions, past research efforts have not quite satisfactorily addressed the effects of situational dimensions that will affect gender discourse in the CMC medium. This article represents an attempt to fill the gap by contributing to the knowledge of gender discourse research, with a focus on the interrelationships among learners, task-technology link, group development and time.

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KEY TERMS

Asynchronous CMC: An electronic medium that enables time delayed text-based communication among parties. Examples include e-mail and computer conferencing.

Collaborative Learning: When students collaborate in groups to learn.

Constructive Learning: Describes learning as an active process in which learners interpret experiences to construct knowledge.

Group Development: The study of how groups mature over time.

Groupware: Collaborative software used to aid team work. Examples include e-mail and chat software.

Learner-Content Interaction: Results when learners examine and learn from course materials such as Web-based learning content.

Learner-Interface Interaction: Refers to how learners utilize technologies to communicate with the course content and participate in online learning activities with instructors and other learners.

Learner-Learner Interaction: Refers to interaction among learners.

Social Presence: The degree to which a medium is perceived as conveying the presence of the communicating individuals.

Synchronous CMC: An electronic medium which allows real-time interaction with others who are online simultaneously. Examples include videoconferencing and chat rooms.

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Gender and Diversity in E-Learning[1]

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INTRODUCTION

Multimediality, interactivity, and inter-connection as well as independence of place and time are potentials of e-learning and can bring about an increase in quality and flexibility of learning. E-learning comprises a variety of scenarios, which differ in their didactic approach and application of media technology. Reinmann-Rothmeier (2002) refers to a model of Back, Seufert, and Kramhöller (1998) consisting of three scenarios according to the main function of new media in the learning process. In e-learning by interacting, the new media facilitate interactions between users and the system, in e-learning by distributing, the new media function as distributors of information, and in e-learning by collaborating, the new media are applied in order to support group work. This trisection traces roughly the history of e-learning. Up until the mid 1990s, e-learning mostly consisted of programs on CD-ROMs run by learners on single PC-units. With the spreading of the Internet, the search for and distribution of information via the Web has continuously grown in importance. Currently, efforts are being made to improve interactivity and collaboration between learners and teachers to overcome the isolation of e-learners using CBT. Blended learning concepts evolved and CSCL emerged as a research field to consider technical and didactic aspects of online collaboration.

Influenced by the shift in didactics from an instructional to a constructivist paradigm, current research questions are, however preferences, skills, and demands of users can be integrated into e-learning technology. Along with this development, gender aspects have become a focus of research. In this article, we will first clarify how the co-construction between gender and technology can be understood without lapsing into dichotomous and self-reifying patterns. We will then outline the multifaceted network of gender aspects in e-learning. We aim to develop a list of demands for e-learning scenarios and will propose an approach for technical construction that takes gender and diversity demands into account.

BACKGROUND

Research on gender and ICT has identified multiple aspects that affect gender differences regarding access to and use of computers. On the individual level, attitudes and competencies concerning the application and acceptance of computers are acquired to different extents. For example, more girls and young women use computers in a rather application-oriented way, whereas more boys and young men act rather playful and oriented on programming (Feierabend & Klinger, 2003). On the structural level, there is an obvious segregation of the information technology labor-market in many European countries (Ruiz Ben, 2002), so that women rarely gain influence on new technology development. On the symbolic level, a close link between technology and masculinity still prevails in the European and Anglo-American spheres, hindering girls and women in dealing with ICT.

A closer look, however, also shows that the variation of habits, preferences, and interests of ICT-users is by far more complex and differentiated than the postulation of the “digital divide” and the “female distance to technology” suggests. Gender research has pointed out that women and men are in no way homogeneous groups. The diversity of the users of ICT has to be considered within as well as between gender groups. Referring to the keyword "co-construction of gender and technology", current approaches of gender research examine how gender is being re-constructed in the complex network of interaction between individuals and technology.

Constructive realism (see Meßmer & Schmitz, 2004) means that male or female strategies of behavior concerning the use of technology are not determined by gender or biology. They are multiple, dynamic, and flexible. Aspects such as age, ethnicity, class, education, social, and economic factors shape these strategies of behavior. They emerge, however, in a society in which gender as a structural category is embedded in every social sphere and in which it is present even in technology itself. Consequently, the affiliation to a gender group is often characterized by similar experiences. These experiences may be constructed, but they are real within one's perception and have an effect on the shaping of strategies and future behavior. Therefore user-oriented e-learning has to consider gender differences as well as the plurality of, and the mutual relations between individual, social, cultural, and technical facets.

MAIN TRUST OF THE ARTICLE

The Gendered Interactive Network of E-Learning

A gender- and diversity-oriented development of e-learning has to take all variables affecting the actual use of the technology and their interconnections into consideration: diverse learners, learning scenarios, and e-learning systems.

a. Learners differ in terms of age, gender, and ethnicity, and also in regards to their computer literacy and discipline-specific competencies. Recent analyses have shown that the digital divide in the use of the internet depends less on gender alone than on a combination of age, education, and gender. Whereas male and female members of younger and well educated groups are almost equally online, the number of female users of the internet decreases strikingly in groups of higher age and lower levels of education (Fluck & Wagner, 2003). Learners have different technical and economic resources at their disposal (e.g., computer equipment and programs), and girls and women are still likely to have inferior computer equipment than boys and men (Feierabend & Klinger, 2003). These gender differences are larger in technical and natural sciences and smaller in cultural and social studies (Middendorff, 2002).
Learners differ in their motivations, interests, and values and develop individual strategies of learning. There are many models of learning which classify learners, for example, according to the modality of sensual perception they prefer (visual, auditive, or haptic), the way they collect and process experiences (abstract or concrete), or the extent of instruction and interaction they require (e.g., field dependence). Instead of defining individual learning styles as fixed traits, current research tends to treat them as strategies, which are applied in different situations in order to fulfill different tasks. In addition, research on gender-specific learning preferences does not reveal consistent results. Yet the preference of many women to learn in groups seems to be confirmed (e.g., Leong & Hawamdeh, 1999; Frank, Kassanke, & Suhl, 2002; Rajagopal & Bojin, 2003).
The connection between learning and communication strategies is especially important for collaborative work. The prospects that virtual communication would overcome restrictions women experience in face-to-face communication were not realized. Some studies identified typically "male" competitive and "female" supportive and attenuative communication styles in huge, anonymous mailing lists (Herring, 1996). Communication processes in smaller teams, for example in doubles, via e-mail (e.g., Pohl & Michaelson, 1997) and in professional settings are much less shaped in a gender-specific way. Styles of communication generally depend very much on particular situations and are modified by the degree of anonymity and professionalism, the size of the group and their gender ratio, the frequency of contacts and the topics that are discussed (for details see Cornelius, 2002; Savicki, Lingenfelter, & Kelley, 1996).

b. "Learning scenarios" describe the didactic conception of a course or a seminar, especially the underlying learning theory, the media in use, the design and timing of learning units, the degree of virtuality and the particular demands of the addressed group and the field of study. Learning systems based on behaviorist theories consider behavior and knowledge as results of reinforcing and punishing factors. In CBT or WBT, learners repeat exercises until they are answered correctly (e.g., vocabulary coaches). Exponents of cognitivism do not regard knowledge as acquired information but as a process of understanding and digesting information. For that reason, cognitivist learning programs offer complex situations, problem-oriented mediation of knowledge and they reveal relations and contexts. Communication and cooperation between learners and an active creation of knowledge are essential for the learning process in constructivist theories of learning. Consequently, synchronous and asynchronous communication tools are applied in order to make online collaboration possible. The decision in favor of one theory of learning is a fundamental aspect of the conception of an e-learning course and depends on the learning tasks and the addressed group. Given a gender sensitive view, the preference of women for group learning is an argument in favor of intensified collaboration and blended learning concepts. However, especially women who have familial responsibilities consider the independence of place and time a very positive aspect of e-learning (Sullivan, 2001). Unlike their male counterparts, they usually subordinate time for learning with computers to family demands (Burke, 2000). This aspect should be taken into account for the design and time management of e-learning courses.
   Girls and women generally estimate their computer literacy lower than boys and men, irrespective of their actual skills (Dickhäuser, 2001; HERI, 2000). This self-estimation affects their motivation to participate in e-learning courses. In addition, demands and methods of the field of study influence the participation of women (Claus, Otto, & Schinzel, 2003).
c. E-learning systems offer a wide range of functionalities for organization (calendar, administration, etc.), for content management, and for communication (chat, forum, e-mail, white board, tools for text annotation, etc.). The systems differ not only in the functions they offer, but also in their demand for particular technical equipment and competencies from learners. They vary in the way design, navigation and demands on usability are realized and in the extent to which the learners themselves are permitted to shape the systems. Additionally, the contents and the mediatization of knowledge are of great importance: the language, metaphors, images, and examples the system uses and the manner in which knowledge is presented and connected, for example hierarchically or in semantic nets (for overview, Campbell, 1999; Schmitz & Meßmer, 2005).

The Implementation of Gender and Diversity in E-Learning: From Analysis to Construction

Alterations in e-learning have to take the multiple and interactive aspects of e-learning into consideration. At the same time they should respect gender demands. A change for the better, however, cannot occur with development of special learning methods or technical systems which are thought only for women. This would only redefine gender stereotypic behavior and role assignments. It is more important to develop didactic concepts that take the varied requirements, precognitions, media biographies, learning styles, motivations and interests of the learners into account (Schinzel, 2001).

In the last couple of years first guidelines were developed that are applicable to the different aspects of the interactive network of e-learning (see Table 1).

FUTURE TRENDS

The constructive change towards the implementation of such guidelines into e-learning technology is characterized by the realization that both the learners and the teachers are actors in the e-learning network. Feminist approaches foster the elimination of the exact division between software design-

Table 1. Examples of guidelines for gender sensitive e-learning (for details see Schinzel & Ruiz Ben, 2002)

Work organization and the curriculum:
Avoidance of gender specific division of labor (men for engineering/women for content)
Gender adequate definitions, for instance media skills that take social abilities and reflective competencies against technology into account
Forms of learning that foster co-operation and augmented creativity
Didactical methods for new media:
Contextualized content instead of abstract topics
Examples relevant to real life and personal experiences
Avoidance of specifications based on the context of men's lives (as opposed to women's): unbiased representations of gender, gender neutral language, a well-balanced selection of topics, gender independent role appropriations and unbiased gender content
Didactic based on constructive learning theories
Multimodal designs, graphic and dynamic representations, alternative forms of representation for diverse learning styles, interests and experiences
Development of sensitivity to role stereotypes, and the discussion of differences
Technical support
Technologies that are suitable for everyday use and easily manageable rather than overloaded
Facilities for users to design and shape technology
A learning environment designed for learner-centeredness, experimental and explorative learning (constructive principles)
Implementation of various possibilities of navigation
Development of technological support of group work

ers on the one hand, and software users on the other (Crutzen, 2004). When users can better customize the technological tools for their respective requirements, then the plurality of the actors and their needs can be better allowed for.

One trend is to offer tools in large e-learning platforms for all possible requirements. However, the acclimation to these huge systems frequently turns out to be very time consuming and they often require particular hardware or software equipment. Possible results are a reduction of motivation and withdrawal from the learning scenario. Alternative concepts favor modular solutions in e-learning development (Meßmer et al., 2003) where simple and intuitive user surfaces can be made available. Teachers and learners can then choose and combine only those functions they need for their particular class, (e.g., content management, e-mail, forum, or chat for communication, text editing functions for collaborative work, or tools that facilitate role distribution between learners and teachers). At the same time, users can also design the e-learning room with a few technical details (color, order of buttons, etc.). This allows for autonomous experience with the technology. The accessible functionality and interactive ease of learning can help reduce technical barriers and deficits in learners' motivation. Additionally, the modular principles keep the system open for implementing further functions with increasing computer literacy of the users or new demands during the learning procedure.

In a modular system tools can be integrated that permit different learning strategies to serve the constructive approach to learning. A current area of research focuses on the development of gender sensitive technical support for information structuring and the visualization of contextualized and complex networked knowledge content. Based on concept maps, teaching and learning environments are set up so that the learners' different strategies of knowledge acquisition can be considered. These knowledge structures must be visualized with adequate tools and must be accompanied with navigational support that is sensitive to gender and diversity. By the means of flexible and selectable navigational tools (e.g., hierarchical and/or networked navigational aids), various navigational preferences can be taken into account.

In relation to the requirements necessary for collaborative work, multi-optional means of communication with combined synchronic and asynchronous tools (e.g., collaborative text edition and text writing facilities) support study groups in conjointly discussing subject matter or in presenting results of their work together (Schmitz & Meßmer, 2005).

CONCLUSION

The contradictory results of gender differences in e-learning allows for the assumption, and even the hope that we are presently in a phase of upheaval. The discussion of gender and ICT often seems even more stereotypical as it actually turns out to be in practice. Within each gender group there is a plurality and diversity of behavioral strategies. In addition, the role of gender in exposure to and in the perception of technology and its symbolic content are constantly in transition (Wajcman, 2002). Against the background of co-construction of gender and ICT this dynamic may improve the inclusion of women in the information technologies. With a focus on e-learning this inclusion can be supported by guidelines combined with appropriate technical developments. Implementation of plurality and diversity in didactic methods and technological design, and the users opportunity to shape technology according to their own needs are challenges for a gender adequate constructive change.

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KEY TERMS

Blended Learning: Type of e-learning that combines virtual phases of learning with classical activities of face-to-face learning, such as workshops, seminars, courses; also known as mixed, integrated or hybridist learning.

CBT: In Computer-Based-Training electronic programs are used to support the learning process in a dialogic manner. Texts, images, sound, video, or animations are combined. The learning software is only available for locally installation on the learner's computer. Communication via internet is not possible.

Collaborative Learning: Collaborative learning denotes learning in group work. In e-learning mediated collaboration, the focus is on the collective effort to complete all tasks that are intended for the learning process. Effective communication is a central prerequisite for effective collaboration.

Concept Maps: Concept maps structure multi-faceted knowledge based on interconnected ontologies. In XML based Topic Maps, for example, topics (keywords, themes) are linked by associations and all can refer to objects (resources, URLs).

CSCL: Computer-Supported Collaborative Learning is an interdisciplinary field with the aim to create a better understanding of collaborative learning that is mediated by computational technologies. On the basis of social, psychological, pedagogical and learning theories CSCL facilitates, develops, and analyzes group work, communication and collaboration processes, information sharing and role distribution in teams.

E-Learning: In general, e-learning denotes all learning scenarios with new media. In a more closely definition e-learning has to fulfill all of the following characteristics: (a) The use of modern multi media technology, (b) the use of a range of autonomous and interactive learning facilities, (c) individual supervision as needed and, (d) the use of electronic data and communication networks.

WBT: Web Based Training was developed from CBT. Courses in WBT are accessible via the internet and offer additional alternatives to communication and interaction between learners, teachers and tutors via e-mail, chat or forum. In WBT changes in course content can be made while the course is still taking place.

ENDNOTE

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Gender and Education in Oral Traditions, Culture, and ICTs

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INTRODUCTION

Seelampur, situated in the northeastern part of Delhi, the capital city of India, is characterized by low-income groups, high population density and poor civic amenities. It is a Muslim-dominated area with a high density of population and low family incomes. The average monthly family income is about 60-80 United States (U.S.) dollars, and the average family consists of eight members. Within Seelampur, the area of Zaffarabad (having approximately 90% Muslim population) stands out as a pocket of extreme urban poverty and immensely poor living conditions; open drains are clogged with sewage, power breakdowns are frequent, houses are dilapidated and people are residing in overcrowded lanes. Lack of opportunities in terms of education and employment also mark the life for people here. Formal education has become quite common, and thus, enrolment is high, but dropping out at different grades is a continuing problem. Most young women have not completed high school, as they usually drop out of the school after finishing Grade 8. Datamation Foundation initiated some work in the area, particularly with women, in 2002. At this time, UNESCO launched a pilot initiative to innovate and research social and technological strategies to put information and communication technologies (ICTs) in the hands of the poor. This seemed a good opportunity in the given context, so an ICT center was set up at Zaffarabad. The initiative seeks to deploy ICTs to address urban poverty and is designed to empower the women of Seelampur.

Figure 1.

BACKGROUND

The Cultural Settings

The towering minarets of numerous mosques in the area are indicators of the role played by religion and the clergy in the lives of the community. Traditional customs still play a powerful role, especially with respect to gender. Women are expected to be good housewives, look after their husbands and in-laws, procreate and take care of children and the house. They are not encouraged to move out of the locality independently, and the "Burqa" (veil) system is prevalent. Many other traditional practices are also still adhered to, such as with respect to kinship and arts, handicrafts and learning. It was considered that for the initiative to make inroads into the lives of the women, it may be useful for the ICT center to be located in their midst. Thus, collaboration was formed with the Babool-Uloom Madrasa. It is a Madrasa (a place of religious learning) and Masjid (the place where prayer is offered and is also the center of other religious activities) headed by the Maulana (refers to leader of prayer, Muslim caliph). The Babool-Uloom Madrasa is a religious residential school providing learning to about 200 boys from humble backgrounds. While women are not allowed entry into the mosque, they do come to the Maulana for advice. He arbitrates on social disputes and religious matters. Keeping this situation in mind, permission was sought to start the ICT center at the Madrasa, and for this purpose, space was also requested. The factor that played a positive and decisive role was not that the key people viewed ICTs as important but they felt a strong need to create some opportunities for women in the area. Indeed, it was much later that they began to understand the utility of ICTs.

The ICT center provides an open learning center for girls and women. They not only receive training on computers and the Internet, but also obtain information on varied topics. Interactive multimedia content is developed and used to support vocational and life-skills training and provide rights-based information on various areas to poor girls and women. The marginalized women use ICTs to learn marketable skills and build their awareness of health issues, their rights and livelihood opportunities. In contrast, the Madrasa has its own philosophy, where it seems to isolate itself from the outside world and the teachings have little influence of the outside, changing world. For ICTs to establish their appropriateness, an overall evaluation is necessary. In an ideal world, universal access to information would create a global information society, yet the mode of interpretation will depend on the culture and traditions of the people and societies. Yet, the endeavor in community-based interventions has been sensitive to cultural differences, which was also the point of departure for the present initiative. The decision to set up the ICT centre in the annex (one room) of the Madrasa gave it immediate legitimacy. Appreciating the socio-cultural scenario and the importance of the Masjid and Maulana in the lives of the community helped to harmonize that with the technological tools.

In today's information age of globalization, computerization, the Internet and the virtual world, there are fears that the global media is fast promoting a global monoculture that denies diverse socio-cultural realities. It is felt that this process of globalization may swamp the not-so-strong cultures. English is the predominant language of the information age. The majority of material on the Internet is from developed and industrialized countries. Thus, there are fears that local cultures would be eroded, so the tendency is to further isolate themselves. The global village is not global for most of the world's poor, not simply because technology is not available to them, but because with or without these technologies the poor are likely to remain marginalized from the benefits of society if they are excluded from the benefits of overall development. Apart from this is the issue of language and content, because of which even if computers may be physically available they may continue to be "out of reach" in crucial ways. Thus, the intervention was located within this fraught relationship between the modern-global and the traditional. There is an interesting contrast between the possibilities of globalized culture that the computer/Internet represents while being at a place that fiercely protects the local culture. What have been the experiences?

HOW THE ICT INTERVENTION HAS ADAPTED TO CULTURAL VALUES

It was felt necessary to embed the project in the community, taking into account existing cultural values. Concrete actions are being taken to preserve the local oral culture and propagate the same. For culture to grow, it must be active, contextual and social. ICTs, such as videos, TV and multi-media computer software that combine text, sound and colorful images, are used to provide media for expression, acting as facilitator. The Ethnographic Action Research (EAR) revealed that women spend a considerable time at home watching soap operas and Hindi movies on television. Seeing the glamorous people on screen, they too are keen to dress well and dance and sing like them. They are also keen to act. The ICT center provided them a platform and an opportunity to express their talents. At the Madrasa, singing is taboo. So the girls sing "Naaths" (odes to God), with their heads covered in reverence. These along with stories, comic skits and plays have been recorded at the ICT center. Technological skills have been acquired in the process of expressing talents. Digital photography, downloading on the computer, sound recording are some of the skills learned in the process. Elderly women are being encouraged to record old songs, lullabies, recipes and home-remedies for illnesses. This initiative is named “Seelampur Voice.” CD-based programs of this nature are cablecast for wider viewing by the community. The endeavor is not only to preserve the local culture by recording, but also to encourage others to come forward to share their experiences, talent and learning acquired through their elders. The learning of local art and handicraft is being encouraged in the process of learning computers. The girls bring local traditional designs and patterns of embroidery to the center. These are computerized through the process of scanning or digital photography. Then these pictures are modified and improved, and more innovative designs are developed with various color combinations. Some of the participants download various patterns from the Internet and then evolve their own designs using traditional and modern tools as a base. It is the same with the application of intricate Mehendi patterns, traditionally made on the hands and feet of women. These designs, which are created, are transferred on various products (Indian handicrafts) and are taken to different exhibitions all over the country. Sale through these exhibitions and from the center itself has enabled the participants to generate about Rs. 50,000 in the year 2004-’05. Seeing the encouraging response at these exhibitions, the Foundation undertook an e-commerce endeavor, wherein a portal (www.seelampurmart.org) was set up in November 2004. The Web site provides a platform for buyer-seller/producer interaction, business transactions and e-commerce.

The Internet in conjunction with eNRICH, a local Web-based browser, is being used imaginatively to record and showcase local talent and cultural heritage. At the same time, the participants are getting exposure to other cultures and ideas. Thus, computers and the Internet create the possibility for such mutual sharing and learning. E-mail has opened an avenue to have exchanges with people of the same religion living in different countries. Images from the Internet coupled with e-mail exchanges are making participants aware of the cultural differences and similarities among Muslims living in countries like Malaysia, Bangladesh, Pakistan, West-Asia and the West. Looking at cultural aspects with a sense of enquiry and respect has been a big gain from the ICTs. Hindi and Urdu are used along with English to facilitate learning. Some computer-based learning programs in the form of vocational CDs have been developed, with voiceovers and content in Hindi as well as English. This was done for easy comprehension and for the realization of the importance of English as a link language (especially for using the Internet). Above all, there is an informality of atmosphere so that the staff and project team members are open to approach.

Studies have shown that despite its criticality to the success of information technology projects, culture is the most difficult to isolate, define and measure. From the conclusions of the studies, every country must have an information technology policy that recognizes its culture and ensures that adoption of information technology does not destroy the cultural heritage. The problem arises when there is a difference between the “culture of an IT product and the culture of its users.” Hence, every possible effort has been taken to develop local content in Seelampur. It was observed that girls were keen to acquire certain vocational skills while learning to handle computers. To fulfil this need, CD-based vocational skills learning packages were developed in-house, where participants have been actively involved. The packages, with a voice-over option in both English and Hindi, include candle making, liquid soap and phenyl making, henna application and designs, making of soft toys and rag dolls, tailoring and so forth, and are based on their traditional skills (such as handicrafts). Many new avenues are being explored to make these girls have a means for an independent income. Many of the girls eagerly desire to have an independent source of income after coming to the center and to be able to support or help their families financially.

Right from the start (April 2003), the computer center is seeing the participation of more than 100 girls each month, who come there both for computer and vocational skills learning. The tutor at the center is from the same community, so the girls feel comfortable. Sensitivity has also been shown, in that the girls from the community are not allowed to move unaccompanied, especially outside the confines of Seelampur. Consequently, in any event, such as the WSIS meeting or the Knowledge Fair at Global Development Network meet, or for the trip to Agra city that adjoins Delhi, adequate travel arrangements were made and it was ensured that the girls were escorted to and from. Thus, they were not denied the opportunity for the exposure because of these mobility restrictions.

HOW THE COMMUNITY AND THE CLERGY HAVE ALSO ADAPTED

There are the traditional restrictions on mobility. Added to this is the fear of the "anti-social" elements that prohibit parents and husbands in Seelampur from sending women from their homes outside Seelampur. Sexual harassment of girls is quite common in the area, and one hears of such cases frequently. The Community ICT Center has gradually emerged as a "nodal" point of social contact in Seelampur, as this is perceived as a safe place. Many women state that they feel very happy coming here and want to stay here for longer periods. Some women have profusely thanked the team at the center for providing them an opportunity to "constructively" interact and socialize. Now, older women and men in these families also support them in this interest. Several opportunities have been created, such as picnics and other visits, to facilitate their mobility even outside the area.

The center is on the first floor of the annex to the Madrasa, with an independent entry from the lane. The girls were allowed to enter the Madrasa from a side entrance, go up to the second floor, transit through the dormitory being used by the boys and then cross over to the annex. The girls were apprehensive of the arrangements, especially of going through the dormitory, but the arrangement worked. Though girls are not allowed into the Masjid, they were permitted to transit through the exclusively boys' zone in this instance.

FUTURE TRENDS

There is Resistance to ICT-Enabled Education

There are occasions when traditional values are too strong and play a decisive role. In such situations, the women may raise a voice or submit to tradition. The center was formally inaugurated by the Chief Minister of Delhi on June 26, 2003. The girls were enthusiastic and so were guided to organize the center, make arrangements to receive the honorable guest and present themselves appropriately. The Maulana was the chief coordinator. It had been planned that after the formal inauguration of the center, the Chief Minister would be escorted to a hall that serves as the Madrasa as also the Masjid, where she was to be felicitated publicly. After that she was to address the gathering. Yet, despite their efforts because of tradition, the girls were not permitted entry into the hall. Often within the kinship context, age-old patriarchal values may reinforce themselves, even if by raking new forms in the face of these changes. Recently in Seelampur, girls are being rejected in the process of spouse selection in arranged marriages on the grounds that they know computers so they will not "adjust" in their marital family. Similar instances have also come to light about the boy's kin making greater demands for dowry from the girl's family if she is computer literate. Voices are raised in dissent.

The girls remain in awe of the Maulana because of his status and traditional standing. During the month of Ramadan, he wanted the centre to be closed down. All through the month of Ramadan devout Muslims keep strict fast. Only before sunrise and after sunset do they take food. In early morning, as the call for prayer is heard from the mosques, the boys and men set off to offer Namaz (prayers). Women stay at home and recite the "Quran." Fasting during the days of Ramadan normally does not affect their daily routine and they go on with their daily chores. Thus, the 29 or 30 days of the month of Ramadan pass and the sighting of the new moon brings glad tidings of Eid-ul-Fitr and the end of the month. The girls were not happy with the decision that the center be closed down for the month of Ramadan. They were enjoying the learning experience at the center. They were encouraged by the project staff to go through the relevant Web sites to understand the significance and meaning behind the rituals and why Ramadan is observed. Having understood, they gathered courage and went to the Maulana to plead their case to keep the center functioning. They did that convincingly and successfully. The compromise arrived at was that the center would close down at 4 p.m. instead of at the usual 5 p.m. Only a few months ago, such a dialog between the Maulana and the girls would have been unthinkable.

Despite remarkable achievements, it would not be out of place to mention that the project of this nature cannot succeed if the enabling technologies and environment are not supported by enabling role models. The ICT project certainly requires technical support and infrastructure in terms of trained people, assured power supply, phone lines and a suitable environment. Importantly, the project leverages on the skills and competence of the local women, by channeling these into income-generation opportunities. With the help of Tele-Centre income, sales proceeds of the SHGs selling their arts and crafts apart from the fee paid by the women (very nominal); the project is sustainable. Many examples of increased confidence, as the center provides women an opportunity to socialize and be creative and search for information and learn new skills, make the center unique and desirable. For the project to be sustainable in the long run, there is a need for careful monitoring, ensuring that the situations of the marginalized and vulnerable are not worsened unintentionally. This monitoring system is in place, which would ensure sustainable benefits and outcomes. A revenue model for the project has also been set up, wherein the buyer who gets linked with the women producers of products and services pays the Foundation a fixed amount per annum as a transaction fee for merchandising with the women. These sources of income will ensure continuing sustainability of the project, as the buyer of embroidery products made by the women of Seelampur will pay a fixed royalty to the Seelampur Community ICT Center.

CONCLUSION

These small steps lead to changing relationships and practices and adapting of old values to new situations. The project has provided an opportunity to participants to interact with the external world and come in direct contact with the ultimate buyers of their products. Development of innovative and interactive multimedia packages to support vocational and life-skills training and provide rights-based information to women has been one of the satisfying and useful activities of the project. The action researchers have been increasingly involved in providing vocational training to women visiting the center. Through the project, about 1,000 women have been computer trained. Greater faith in the capacity of girls and the need to educate them has been generated. As we go along, these seemingly small changes may go on to impact the culture. Culture is how we view events, how we think, how we perceive events, and how we react and respond. Culture consists of social norms, group behavior, respect and authority of decision makers. This experience shows that while every effort is being made to respect the local culture, the project is also impinging on the participants and the stakeholders, making them think and act a little differently. Earlier, there were doubts as to whether the space would continue to be provided by the Madrasa or the center would have to shift. The outcomes are very evident in the fact that now there is a commitment to give the space for the center for many years to come, and an extra room has also been provided for the center. The initiative has shown that ICTs can be utilized to understand, preserve and share cultural heritage apart from enhancing cultural values. Local culture can be shared with people of different cultures with mutual understanding and respect. The exposure builds confidence in the women, and they are able to articulate their opinions better. The Seelampur Community ICT center initiative has been an interesting learning experience for the community as well as for the project ream.

KEY TERMS

Burqa: A loose garment (usually with veiled holes for the eyes) worn by Muslim women especially in India and Pakistan.

Eid-ul-Fitr: A festival that ends the fast of Ramadan.

Imam: The Muslim worshiper who leads the recitation of prayer when two or more worshipers are present.

Madrasa: A building or group of buildings used for teaching Islamic theology and religious law, typically including a mosque.

Masjid: The place where prayer is offered; also the center of other religious activities.

Maulana: Refers to the leader of prayer, Muslim caliph.

Mosque: A Muslim house of worship.

Naath: Odes to god.

Ramadan: The ninth month of the year in the Islamic calendar is the month of Ramadan. During this time a fast is held from sunrise to sunset.

Gender and End-User Computing

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INTRODUCTION

Although gender differences in a technological world are receiving significant research attention, much of the research and practice has aimed at how society and education can impact the successes and retention of female computer science professionals. The possibility of gender issues *within software*, however, has received almost no attention, nor has the population of female end users. However, there is relevant foundational research suggesting that gender-related factors within a software environment that supports end-user computing may have a strong impact on how effective male and female end users can be in that environment. Thus, in this article, we summarize *theory-establishing* results from other domains that point toward the formation of grounded hypotheses for studying gender differences in end-user computing.

There has been much background research relevant to human issues of *end-user computing*, which we define here as problem-solving using computer software, also termed *end-user programming* in some of the literature (e.g., Blackwell, 2002; Green & Petre, 1996; Nardi, 1993). (See the glossary for definitions of these and related terms.) Despite this, few researchers have considered potential *gender HCI issues* and gender differences that may need to be accounted for in designing end-user computing environments. The most notable exception is Czerwinski's pioneering research on the support of both genders in navigating through 3-D environments (Czerwinski, Tan, & Robertson, 2002; Tan, Czerwinski, & Robertson, 2003). Although individual differences, such as experience, cognitive style, and spatial ability, are likely to vary more than differences between gender groups, evidence from Czerwinski's work as well as work in other domains, such as psychology and marketing, has found gender differences relevant to computer usage. In fact, some research has shown that some software is (unintentionally) designed for males (Huff, 2002).

One reason gender HCI issues in end-user computing are important is that ignorance of gender issues has already proven to be dangerous: today's low percentage of computer science females (Camp, 1997) has been directly attributed to the past unawareness of gender issues in computer science education and in the workforce. There is a risk that if gender HCI issues in end-user computing environments are ignored, a similar phenomenon could occur with female end users.

WHAT COULD GO WRONG?

What gender differences might matter in the design of end-user computing environments? Consider the following scenario in one particular end-user computing environment.

Imagine a female teacher engaged in preparing a spreadsheet to track her students' scores and to calculate ways of providing students with the best grades. Part of her process of preparing her spreadsheet is to test the spreadsheet. While she is engaged in testing, the system surprises her by decorating some of the spreadsheet cells, as in Figure 1.

The surprises were intentionally placed into the software by the designers relying on a strategy for

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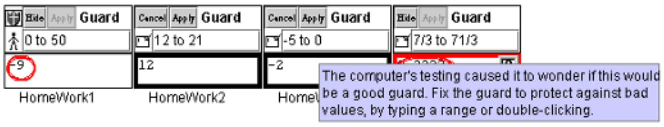
Figure 1. A spreadsheet calculating the average of three homework scores. Assertions about the ranges and values are shown above each cells' value. For example, on HomeWork1 there is a user-entered assertion (noted by the stick figure) of 0 to 50. The other three cells have assertions "guessed" by the Surprise-Explain-Reward strategy. Since the value in HomeWork1 is outside of the range of the assertion, a red circle notifies the user of the violation. A tooltip (lower right) shows the explanation for one of the guessed assertions.



end-user computing environments called *Surprise-Explain-Reward* (Wilson et al., 2003). The surprise, which was intended to capture the teacher's attention and arouse her curiosity, reveals the presence of an "information gap" (Lowenstein, 1994). In this case the system is using the surprise to interest her in assertions (Burnett et al., 2003), which she can use to guard against future errors by specifying, for example, that the value of a cell calculating a grade average should always fall between 0 and 100.

What could go wrong in surprising the user? According to Lowenstein's information gap theory, a user needs to have a certain level of confidence in order to reach a useful level of curiosity (Lowenstein, 1994). However, given documented gender differences in computer confidence (Busch, 1995; Huff, 2002), the teacher's level of computer confidence could interfere with the surprise's ability to capture her interest.

Returning to our scenario, suppose for this particular user, the surprise is effective at arousing her curiosity, she looks to the object that surprised her (the assertion) for an explanation. The explanation, viewed through a tooltip, includes the semantics, possible actions she can take (regarding the assertion), and the future reward(s) of taking the action. See Figure 1.

What could go wrong with the explanation? According to one theory, males and females process information differently (Meyers & Sternthal, 1991; O'Donnell & Johnson, 2001), and thus both the presentation and the content of the explanation may impact its effectiveness for males versus females. If the information needed by the user is not effectively communicated, the user's ability to problem solve is likely to be reduced.

Another role of the explanation is to help users make a reasonably accurate assessment of the risk in taking some action—but since males and females differ in their perceptions of risk (Byrnes, Miller, & Schafer, 1999), the explanation may need to serve these two populations differently in this respect as well. (An example of risk may be the fear that the user will lose their work if they try a certain feature.) If one gender perceives an explanation of a feature as communicating higher levels of risk than another, the users with higher risk perceptions may avoid supposedly "risky" features that may be important to overall effectiveness.

Perhaps the most important role of explanations is to make clear the rewards of using particular features of the software. Providing information about rewards in the explanation is consistent with the implications of the Model of Attention Investment (Blackwell, 2002), an analytic model of user problem-solving behavior that models the costs, benefits, and risks users weigh in deciding how to complete a task. An implication of this model is that if the system provides the user an idea of future benefits, users can better assess if the cost of using a feature (here assertions) is worth their time. The reward aspect of the strategy refers to rewards such as the automatic detection of errors, which is depicted by the red circle around HomeWork1's erroneous value in Figure 1.

What could go wrong with rewards? Since males and females are often motivated by different factors, there may be gender differences in what actually is a perceived "reward." If the rewards are only tailored to one gender's perceptions of rewards, the other gender may not be motivated to use the devices that will help them be effective.

In this end-user computing scenario, potential problems arose *that may be addressable within the end-user computing software itself*. Four issues that arose here were (1) software features whose effects depend upon users' computer confidence (discussed in the section on *confidence*), (2) the software's ability to communicate effectively with users (discussed in *support*), (3) the possibility of a user's perception of risk interfering with the user choosing to use appropriate features (discussed in *confidence*), and (4) possible differences between a user's actual motivations and the software's attempt to "reward" users for using particular features (discussed in *motivation*). These issues together form a useful organizational framework for considering gender HCI.

CONFIDENCE

This document uses the term "confidence" for the interrelated concepts of self-confidence, self-efficacy, overconfidence, and perceived risk.

From the field of computer science, there is substantial evidence of low confidence levels as computer science females compare themselves to the males (Margolis, Fisher, & Miller, 1999). Of particular pertinence to end-user computing, however, is the evidence showing that low confidence relating to technology is not confined to computer science females (Busch, 1995; Huff, 2002; Torkzadeh & Van, 2002).

As a measure of confidence, researchers often use self-efficacy, as was done in the Busch study. *Self-efficacy* is belief in one's capabilities to perform a certain task (Bandura, 1994). There is specific evidence that low self-efficacy impacts attitudes toward a new software package prior to its use (Hartzel, 2003). Taken together, this research suggests that a first experience with end-user computing software can impact attitudes which may in turn impact users' future choices to (or not to) use some features in their software.

Overconfidence matters too, because it can prevent people from suspecting errors, leading to misplaced trust in erroneous programs. In particular, overconfidence in spreadsheet correctness is common (Panko, 1998). There is evidence (Lunderberg, Fox, & Punchochar, 1994) suggesting gender differences in overconfidence just as in under confidence. Hence, designing methods to help alleviate overconfidence in end-user computing needs to be carefully targeted specifically toward overconfident users.

Perception of risk is tied to confidence, and impacts the decisions people make. According to the attention investment model (a model of how users allocate their attention in problem solving) (Blackwell, 2002), a user may choose not to follow through a particular action, if they decide that the costs and/or risks are too high in relation to the benefits of taking that action. Perception of risk thus plays an important role in a user's decision-making about whether to use some features, and can lead to differences in actual behavior.

Differences in perception of risk have been tied to gender. For example, a meta-analysis of 150 studies on gender and risk taking found that females engaged in less risk taking than males (Byrnes, Miller, & Schafer 1999). The meta-analysis did not address risks of computer use directly. However, it did find that intellectual risk taking, defined as activities involving mathematical or spatial reasoning skills, was greater in males than in females (Byrnes, Miller, & Schafer 1999).

To obtain evidence about whether confidence might directly impact gender HCI issues for end-user computing environments, we conducted a preliminary think-aloud study in which participants attempted to debug two spreadsheets, given the support of Surprise-Explain-Reward devices (Beckwith & Burnett, 2004). To our surprise, the females' confidence levels dropped *over the course of the study* much more than did the males' confidence levels. This result suggests that end-user computing environment itself—which, like other end-user computing environments, was designed without knowledge of gender-related HCI principles—is not currently serving the females' needs as well as the males'. A subsequent follow-up study (Beckwith et al., 2005) confirmed this: in the spreadsheet paradigm, ties were found between females' confidence issues and low utilization of features aimed to support problem solving, resulting in effectiveness problems.

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SUPPORT

We will use the term "support" to mean built-in aspects of the software, such as on-line help systems and Figure 1's tooltips that help users learn or understand the environment.

The system's approach to help users achieve mastery in remembering the software's devices may depend on a user's learning style. One survey of university students found that students with an "abstract random" learning style were significantly more likely to be female and, as a result, could find computer-based instruction ineffective for learning (Ames, 2003). Other researchers have also found gender differences in learning styles (Heffler, 2001; Severiens & ten Dam, 1997). One implication of these findings is that end-user computing may need to support several learning styles, especially if some users are easily dissuaded by support devices not sensitive to their learning style.

Problem-solving style also shows gender differences, at least for computer games (Kafai, 1998). Researchers found that, unlike boys, rather than working in a linear fashion through the game, girls prefer to explore and move freely about a game (Gorriz & Medina, 2000). In another difference in problem-solving style, boys' games typically depend upon competition, whereas girls prefer collaboration and working together (Kafai, 1998). For end-user computing environments, these problem-solving differences suggest differences in the support provided by the system. For example, supporting both linear and non-linear problem-solving styles and providing avenues for both competition and collaboration may be important for software's success at supporting both genders adequately.

Finally, the theory of selectivity suggests gender differences which may impact how users process the information support devices provide. The theory of selectivity, from research in the area of marketing, states that males and females differ in their information processing strategies (Meyers & Sternthal, 1991; O'Donnell & Johnson, 2001). According to this theory of selectivity, females are more likely to employ elaborative information processing strategies, regardless of whether the task is simple or complex in nature. Males, however, are more likely to select heuristic processing strategies that minimize cognitive effort and reduce information load for simple tasks, switching to an elaborative strategy only on more complex tasks.

These gender differences have been shown to impact diverse software-related activities, ranging from users' perceptions of Web sites used for e-commerce (Simon, 2001) to users' performance on auditing tasks (O'Donnell & Johnson, 2001). For end-user computing environments, this research may have implications for informing end users of important information via the software's support devices.

MOTIVATION

Research has shown that computer science females are motivated by how technology can help other people, whereas males tend to enjoy technology for its own sake (Margolis, Fisher, & Miller, 1999). These differences are also found with other females who use technology, such as architects, NASA scientists, and filmmakers. One study (Brunner, Bennett, & Honey, 1998) found that females described technological objects as tools to help integrate personal and professional lives and to facilitate creativity and communication, whereas males described them as technological devices to increase command and control over nature and one another. The gender differences found in that study are summarized in Table 1.

The technology acceptance model (TAM) (Morris & Dillon, 1997; Venkatesh & Morris, 2000) provides a model of users' acceptance and usage behavior of technology. According to TAM, user acceptance, and ultimately technology use, is determined by two key beliefs: perceived usefulness and perceived ease of use (Venkatesh & Morris, 2000). "Perceived usefulness" is the degree to which a user believes that using the system will enhance their performance, and "perceived ease of use" is the degree to which the user believes that using the system will be free of effort. According to one study, the relative importance of each differs by gender (Venkatesh & Morris, 2000); women were more influenced by perceived ease of use whereas men were more influenced by perceived usefulness.

Table 1. Summary of gender differences in fantasizing about technology (Brunner, Bennett, & Honey, 1998). Reprinted with permission.

	Women ...	Men ...
1	fantasize about it as a **MEDIUM**	fantasize about it as a**PRODUCT**
2	see it as a **TOOL**	see it as a **WEAPON**
3	want to use it for **COMMUNICATION**	want to use it for **CONTROL**
4	are impressed with its potential for **CREATION**	are impressed with its potential for **POWER**
5	see it as **EXPRESSIVE**	see it as**INSTRUMENTAL**
6	ask it for **FLEXIBILITY**	ask it for **SPEED**
7	are concerned with its **EFFECTIVENESS**	are concerned with its **EFFICIENCY**
8	like its ability to facilitate **SHARING**	like its ability to facilitate **AUTONOMY**
9	are concerned with **INTEGRATING it** into their personal lives	are intent on **CONSUMING** it
10	talk about wanting to **EXPLORE** worlds	talk about using it to **EXPLOIT** resources and potentialities
11	are **EMPOWERED** by it	want **TRANSCENDENCE**

FUTURE TRENDS AND CONCLUSION

To date, there has been little research on how the design of software itself may interact with gender differences. Still, foundational work from several domains strongly suggests that such differences may have critical impacts on users' success in end-user computing.

Although research is beginning to emerge providing some insights into gender's importance in end-user computing environments, it is still largely an open question. Also open are questions of what specific types of differences matter in such environments and what amelioration strategies are possible.

To help provide a foundation upon which researchers interested in these issues can build, this article has drawn from five domains to summarize literature relevant to these questions. All of the literature surveyed identifies one or more issues that potentially impact end users' success that are also potentially addressable *within* the software systems. Together, the open questions and survey are intended to provide a foundation for future investigation.

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KEY TERMS

End User: Users who are not trained programmers.

End-User Computing: Computer-supported problem solving by end users, using systems such as spreadsheets, multimedia authoring tools, and graphical languages for demonstrating the desired behavior.

End-User Programming: A term synonymous with end-user computing.

Gender HCI: Human-computer interaction (HCI) work that takes gender differences into account.

Overconfidence: Higher self-efficacy than is warranted by a user's abilities.

Self-Efficacy: Belief in one's capabilities to perform a certain task.

Under Confidence: Lower self-efficacy than is warranted by a user's abilities.

Gender and E-Service in CEE and the CIS

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INTRODUCTION

Information and communication technology is used today as a tool for reducing all kinds of poverty, promoting good governance, and facilitating sustainable human development. NGOs and other practitioners call this ICTD. One example of ICTD is to use different software, e-services, to promote good governance, business and reduce income and non-income poverty. However, there is a risk of ICT imposing new divides. The gender digital divide is a severe and increasing problem. The gender digital divide is the problem of ICTs, regardless of regional variations, affecting men and women differently. Women in most regions face barriers in benefiting from the development of ICT.

During the past few years, the ICT and gender movement and research on the topic has grown globally, but in Central and Eastern Europe (CEE) and the Commonwealth of Independent States (CIS) it has remained weak and without recognition (Simerska & Fialova, 2004). It is important to ask whether women in CEE and the CIS are using the new services and what roles women play within the growing e-service in business and governance in the region. This article describes the situation on women and ICTs in the CEE and CIS and will additionally highlight the potential of ICTs in promoting gender equality.

BACKGROUND

The use of ICTs is becoming increasingly inevitable, and a necessary part of everyday life. More widespread and more affordable than ever this propensity is expected to increase in the future. Researchers such as Pippa Norris have analysed and described the impact of ICT and the importance it has in societies. Norris points out that ICT and e-service applications creates new economic and social opportunities all over the world (Norris, 2001). The report of the Digital Opportunity Initiative exemplifies this by pointing out e-service applications as an important enabler of economic development (Accenture, 2001). These changes however, do not reach or benefit all sectors of society equally. This is the digital divide. Action lines from the 2003 World Summit on the Information Society highlighted that national and international political action must be taken in order for ICT to reduce traditional barriers in society and provide an opportunity for everyone to access local and global markets (WSIS, 2003).

Research by Hafkin (2003), and Huyer and Sikoska (2003), among others, show that, regardless of regional variations, the development of new e-services can affect men and women differently, creating what is known as the gender digital divide. However, they also highlight that ICT can be an important enabler of women's participation and empowerment. Huyer state that if ICT is to become an important enabler for women in the CEE and CIS there is need of promoting political action (Huyer, 2003). Huyer (2003) therefore concludes that ICTs can have a positive impact on gender equality, however, they can sustain or exacerbate inequalities if targeted actions (including policies, regulations, projects, and initiatives) are not taken.

Girard and Ó Siochru (2003) conclude in their research that, since ICT applications alone are unlikely to make a positive contribution to gender equality, there is a need for actions that promote gender issues with ICT applications. This is crucial in the CEE and CIS region because in several countries in region women are totally excluded from ICTs. (Simerska & Fiavola, 2004) These imbalances between men's and women's participation in ICTs can be found in several areas. Such as for example access to, education, decision-making, and content.

RESEARCH AND DATA

Little research has been done in the CEE and the CIS region in the field of gender and ICTs. The most recent UN-report, by Simerska and Fialova (2004) indicate that women use and benefit less from ICT applications such as e-services than men. Except for that report, most surveys in the region are carried out by private companies as market surveys for business purposes. However, these reports are just indications and they advocate for deeper research. One of the main problems is the shortage of gender disaggregated official data to measure the extent of which women are using or being supported by e-services. Few countries in the CEE and the CIS region have access to, create data, or undertake field research, which is a problem that needs to be addressed. Despite the International Telecommunication Union (ITU) recognizing this problem at a meeting in Geneva in June 2003, country specific gender data is still not available. A problem with the available data is the lack of standard definitions. Due to this, most research and data discussed in this article are on ICTs in general, not on e-services specifically. Another problem concerning research is that perceptions of women in the region have not been well documented (Hafkin, 2003). Furthermore, the lack of disaggregated data, the lack of standard definitions and the lack of documented perceptions of women results in little fact-based evidence to support and explain the indications of imbalances between men and women that are reported.

ACCESS AND EDUCATION

According to ITU, the number of telephone subscribers has increased from 14.1 per 100 inhabitants to 44.1 per 100 inhabitants in the CEE and CIS region (WSIS, 2003). Over the past three years, the use of Internet has grown by 117.5 % in the CEE and CIS.[1] These figures indicate that the use of communication channels as Internet and Mobile phones will increase in the future. The possibilities of accessing new ICTs are rapidly increasing globally and regionally, these possibilities should be shared equally. International reports show a different picture, women have less access to ICTs than men (Scott, 2003, Simerska & Fiavola, 2004).

Even if you have access to ICT, you need to know how to use it. Hafkin and Taggart describes education as an important factor in raising the use of ICTs among women (2001). However, women's tertiary education in ICTs in the region constitutes a tangible disturbing issue. Figures from ITU (WSIS, 2003) show that in the new member states of the European Union,[2] 83% of men and 13% of women participate in ICT related tertiary education. Indications from small surveys done in a few CIS countries also signal these kinds of inequalities. These surveys further show that this is one explanation to why women use Internet significantly less then men (Scott, Singh, & Wanasundera, 2001; Hafkin & Taggart, 2001). Hafkin and Tagart (2001) conclude that these inequalities are severe and actions to promote and encourage women to consider a career in ICT must therfore be taken. The rapid growth of and the education inequalities in ICTs highlights the need for immediate actions to ensure equality in both access to and education in these services. Otherwise the gender digital divide might increase.

DECISION MAKING AND CONTENT

In both the public and the private sphere, the main problem is not only women's access to and education in ICTs, but also the structural exclusion of women from the creation and innovation processes of new e-services and decision-making processes. Hafkin (2003) points out an interesting note; there seems to be no correlation between the percentage of female internet users and women's empowerment. The lack of correlation between women's use of Internet and expected empowerment indicators support the hypothesis that most women that use the Internet are not representative of women in the country as a whole, they represent a small elite (Hafkin & Taggart, 2001, p. 15). It also show that if a country only focus on access they will not automatically raise women's empowerment. This indicates that access is not the only problem concerning women's use of ICTs.

As e-services are becoming more and more important as tools integrated in all parts of society, ICT skills in power and decision-making positions are important. Every leader has special competences and skills, but basic ICT competences are becoming and have to become essential knowledge for them all. In the business sector these skills are already a necessity and a requirement. The public sphere is moving quickly towards a similar situation with e-democracy (Masters, Macintosh, & Smith, 2003; Norris, 2003). The UNECE report on women as entrepreneurs show that women in decision-making positions are far less represented then men in both public and private sectors in the region. Social structures and labour market polices reflect the traditional male breadwinner model at macro and micro levels. Women are, for example, encouraged to leave the labour market in Czech Republic and Poland through early retirement policies, and in Belarus and Ukraine through more attractive parental leave schemes (UNECE, 2002). This also shows the exclusion of women from the decision-making processes of how to use ICTs within business and governance. Since women in decision-making positions are less represented and few women have the opportunity to obtain ICT skills there will be less opportunities for women to get a job. Women will also have less opportunities to effect the purpose for what new e-services are being used.

When launching initiatives, as new e-services, concerning the issue of gender inequalities, it is important to relate the content to its' political, socio-economic and cultural context in which they are immersed into account. Public and private initiatives might otherwise sustain region specific problems. (Beneria, 2003). In the public sector, governments in the region have been focusing on providing better and more affordable services, highlighted by Hafkin and Jorge (2002) as well as others. Governments can increase access to public information and programmes through these e-services and widen the spectra of services because of increasing productivity and streamlining. Through e-services the public sector can reform and facilitate an integrated participatory approach to development and decentralization. This is a part of e-democracy. Few of these applications are used to address the primary concerns of women. The end user perspective is very important in order for these services to be utilized and useful; initiatives with a content relating to the work of women in the region would reach out to more potential "buyers/users" of the services and would make them more successful (Primo, 2003; UNECE, 2002). The UNECE report further highlights that when projects and initiatives to promote women as leaders are launched, ICTs are rarely taken into account as a factor and as a promoter. Public and private driven e-service applications should, however, be used to help women change their positions and promote women in decision-making positions. The lack of e-services in women-leader initiatives and the lack of ICT content relating to concerns of women in the region are additional arguments for political leaders to act.

Research and science are important factors concerning how ICTs could be used in the future. Women in several countries of the region are also excluded from science and technology research. Huyer and Sikoska (2003) show that this indicates that women are not integrated in the creating, maintaining or control of new e-service tools and their content. This is one of the reasons, according to Huyer and Sikoska, why new e-service applications do not provide services that address women's needs. Initiatives both by private and public sector, concerning emerging e-service projects in the region, are rarely taking gender content into account. The lack of women in science and technology research therefore also has a negative impact on the opportunities for women to enter decision-making positions. Being excluded from the creation and control processes prevents women from finding their role within the e-service development.

FUTURE TRENDS

In most countries in the region, infrastructure and policies concerning ICTs are now being laid out together with the help of donors and NGOs. Most governments in the region do not consider gender important or are not aware of the benefits of taking gender into account when dealing with ICT structures and policies[3] (Simerska & Fialova, 2004). In Hafkin and Jorge's article in 2002 they point out that if gender is not being considered when policies and structures are being laid out the opportunities to change the social context and structures might get even worse. It is therefore important for these governments to understand the benefits of including women when forming ICT policies and structures. This could increase the use of ICT among women. According to another researcher, Ramilo and Pi (2001), governments should create incitements, through policies, for private and public sector in order to get more women to use and create e-services. NGOs, donors, international- and bi-lateral organizations assisting governments in creating these policies and infrastructures have a responsibility and possibility to advocate and create incitaments for the inclusion of gender and to raise awareness (Simerska & Fialova, 2004). This is an indication that ICTs also could become an important factor for governments relating to achieve and monitor the United Nations Millennium Development Goals (MDGs).

One example where practitioners promote women in ICT is USAID's principal program in Washington for promoting ICT for development, dot-com (www.dot-com-alliance.org). In promoting policy and regulation reforms for sustainable ICT policies, dot-com advocate in an article (Trish, 2005) for the participation of women as a marginalized group. Including marginalized groups when creating new e-services is according to them an important factor of sustainability in the ICT development (Trish, 2005). Based on dot-com experiences in forming ICT policies governments should act while forming new structures, laws, and policies that will have a long-term effect.

Important tasks in the future concern political action in the fields of education, access, decision-making, and science potentially through the use of regulations and policies. Governments in the region also need to start the process of creating disaggregated data by gender to support future academic research. There is a clear demand of further and deeper research especially concerning the topic of new e-service applications and women leaders. Research can also provide a tool for advocacy for increased political actions in the region and outside.

CONCLUSION

The e-services used as tools in everyday life increase social and economic opportunities for women and men. The development of new e-services, (i.e., new opportunites), are increasing. Given the low percentage of women in ICT related education, in decision-making positions and in science combined with the growing importance of e-service applications there is a huge risk of sustaining or exacerbating the old gender inequality structures. E-services are not gender blind tools, they are strongly connected with the political, social and economic structures in which they are created and used.

In the region of Central and Eastern Europe and the Commonwealth of Independent States the foundations in terms of infrastructure and policies are now being formed. This underlines the importance of acting immediately. NGOs and other practitioners acting on the ground and helping governments have a responsibility and a possibility to make a difference. They can create an environment were e-services applications are harnessed by both genders in the region. Women in CEE and the CIS are using the new services far less than men. The exclusion from creating e-service content diminishes women's possibilities of finding their roles within the growing e-service in business and governance. Access and education, content and decision-making and research are all interlinked structures. In the process of creating policies all these issues are important to establish a good environment not only for equality but also for the future of e-services in the CEE and CIS region.

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KEY TERMS

CEE: The region of Central and Eastern Europe include; Estonia, Lithuania, Latvia, Slovenia, Serbia and Montenegro, Bosnia and Herzegovina, Kosovo, Macedonia, Croatia, Albania, Czech Republic, Slovakia, Romania, Bulgaria, Hungary, Malta, Poland, and Cyprus, Turkey.

CIS: The region of Commonwealth of Independent States include; Ukraine, Belarus, Armenia, Russian Federation, Georgia, Moldova, Kyrgyz Republic, Kazakhstan, Azerbaijan, Tajikistan, Turkmenistan, and Uzbekistan.

Disaggregated Data: Simply displaying/analysing data by specific subgroups, in this case gender. Using disaggregated data you can uncover patterns, trends, and other important information.

Digital Divide: Defined as unequal possibilities to access and contribute to information, knowledge, and networks as well as to benefit from development enhancing capabilities of ICT (Accenture, 2001).

E-Democracy: The use of electronic communications to enhance the degree and quality of public participation in government and in the public decision-making process.

E-Service: Viewed as any service or functionality that can be accessed by a business, organisation, authority or a consumer programmatically on the Internet, using standard representation and protocols. It refers to a technology-based service which can offer and includes information, interaction, transaction, and integration within business or authority.

Gender Empowerment: Refers to increasing the political, social, or economic strength of individuals or groups, in this case gender. It often involves the empowered developing confidence in their own capacities. Gender empowerment is measuring gender inequality in basic dimensions of empowerment, for example economic participation and decision-making, political participation and decision-making and power over economic resources.

ICTD: Information and communication technology for development refers to and focus on extending access to ICT, capacities to use it and the deployment of it to address various development opportunities. Levels such as the policy, capacity, infrastructure, content, and organization are addressed. Using ICT as an enabler for development (Accenture, 2001).

Millennium Development Goals (MDGs): Goals that the United Nations agreed on in 2000. The goals with time-bound targets and indicators should serve as an instruments to address the world's most challenging developments. The eight goals are:

1. Eradicate extreme hunger
2. Achieve universal primary education
3. Promote gender equality and empower women
4. Reduce child mortality
5. Improve maternal health
6. Combat HIV/AIDS, malaria and other diseases
7. Ensure environmental sustainability
8. Develop a global partnership for development (www.millenniumcampaign.org)

ENDNOTES

[1] The sum of fixed lines in operation and cellular mobile subscribers divided by the population of a country and multiplied by 100. Which make the possibility of double counting a major drawback (ITU, 2003, p. 73-75).

[2] Lithuania, Estonia, Latvia, Poland, Slovenia, Hungary, Cyprus, Slovakia, Czech Republic and Malt

[3] See Information Society policies and action plans in these countries. Several National Strategy building projects are launched in the region. Moldova is just one example, www.reistru.md/info21_en.

Gender and ICT Policies and Programmes in an Indian State

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INTRODUCTION

The development and use of information and communication technologies have stimulated huge changes in the life of people globally, leading to a process of transition from the industrial to the information society. The ultimate aim of the information society should be the empowerment and development of all its citizens through equal access to and use of information (Goulding & Spacey, 2002).

BACKGROUND

Unfortunately, despite the potential ability of information to empower disadvantaged groups and the massive investments in information and communication technologies, the information society has remained largely silent on gender issues (Jansen, 1989). There is evidence of a gender imbalance in the use of ICT that threatens to restrict women from being equal partners and beneficiaries of the emerging information society, thus creating a gender-based digital divide. Decades of experiences have shown that without explicit attention to gender in policy, gender issues are not considered for implementation (Hafkin, 2002). Policy making in technological fields often ignores the needs, requirements, and aspirations of women unless gender analysis is included (Marcelle, 2002). If gender issues are not articulated in ICT policy, it is unlikely that girls and women will reap the benefits of the information age (Hafkin). Closing one's eyes to this fact can entrench inequality and even enlarge the gender gap, making ICT a "gender-negative" technology (United Nation's Development Programme [UNDP], 2003).

Thus, the issue of mainstreaming gender into ICT policies and programmes in the context of India becomes important, as here the ICT policy and programmes have been viewed by national and state governments largely within neoliberal macroeconomic frameworks of gross domestic product (GDP), employment, and competitiveness (Gurumurthy, 2003) rather than as issues of development or empowerment as well. Moreover, as in most of the developing countries, ICT education in India is largely confined to cities as the institutions that offer ICT education are urban based. While there may be a marginally increased enrollment of women in technical institutes in the last two decades, this has not resulted in more women in ICT-related careers or at decision-making levels. Women are vastly underrepresented in government, business, and social and political institutions even in the urban context. Men still hold most of the management and control positions in ICT-related employment and policy-making bodies. In the ICT-related employment sector, males account for 70 to 75% of the workforce. It has been held that even in the urban context, in the period following education, mobility or a lack of it is a crucial factor that affects the access to ICT and networking capacities of women, which is reflected in the extent of the presence of women in this sector (Pichappan, 2001). Women in India are considered to be the most socially excluded group, and a lack of access to information is being identified as one of the most important reasons for their exclusion (Hooper, 2003). This lack of access to information has added to their alienation from mainstream development activities and empowerment, resulting in increased social exclusion and economic and political marginalization, especially of rural, tribal, and other socially disadvantaged women of India.

A Brief Profile of the Indian State of Chattisgarh

Chattisgarh is a newly formed state of India that came into existence in the year 2000. It is a state richly endowed with natural resources but also marked with severe poverty, backwardness, illiteracy, and ignorance: 79% of the state population lives in rural areas, 32.55% of the population is of scheduled tribes (STs), and 12.22% is of scheduled castes (SCs). During 1999 to 2000, the state was third in share of the rural poor in India, with 11.35% of the total poor. Its low position in social and economic infrastructure and development is well documented (Dev, 2004; Kannan, 2004). The state has been ranked second to last in the list of all Indian states for telecommunications density (report of the Ministry of Communications and Information Technology, http://www.trai.gov.in/dld1.html).

Women in Chattisgarh

Women in Chattisgarh are visible in every walk of life, be it in agriculture, in the collection and processing of the state's rich forest wealth, or in construction and wage work in urban areas. Contrary to the situation in many parts of India, Chattisgarh enjoys a comparatively favorable position in terms of women's population as reflected in the sex ratio, which is 990 females to 1,000 males (census of India, 2001, http://www.censusindia.net/). However, in terms of infant mortality rates, its record is 97 girl deaths out of 1,000 infants, which is the highest in India (Rustogi, 2003). Furthermore, during 2000 to 2001, the school dropout rate (Class I-VIII, i.e., grade one to grade eight in schools in India) in Chattisgarh was 47.15%. This rate was higher among the SC (49.95%) and ST (63.68%) categories. Also, the female dropout rates were much higher than those of males (social infrastructure document, http://chhattisgarh.nic.in/opportunities/Social%20Infrastructure.pdf).

ICT Policies and Programmes

Nevertheless, with the formation of a separate state for its people, the state is aspiring for the prosperity and growth of its people (state vision document, http://chhattisgarh.nic.in/vision/new/Chp%205%20-%20Unlocking%20Natural%20Wealth.PDF). Expressing its commitment toward the development of its woman population, the state has envisaged a very ambitious and comprehensive women's policy (http://chhattisgarh.nic.in/wcd/womenpolicy.PDF). Realizing the importance of ICT, Chattisgarh also has a very comprehensive and ambitious IT policy (http://chhattisgarh.nic.in/policy/IT%20Policy.pdf). After its emergence in November 2000, the state government launched a number of ICT-related schemes and programmes for the benefit and development of its people, which are listed as follows:

1. **Bhuiyan:** All land records are computerized under this scheme. By paying only rupees, anyone can get a copy of the land records. Implemented in all Tehasil (Block) headquarters of the state, it is also planned to be extended to the villages at a future date.
2. **E-Sangwari:** This scheme is implemented with the objective of providing seven services to common citizens and was launched in the Bilaspur district only: (a) death certificates, (b) birth certificates, (c) caste certificates, (d) Form 16, pertaining to income tax, (e) khasaras (land records), (f) income certificates, and (g) domicile certificates.
3. **E-Kosh:** This scheme started in December 2004 to computerize all treasury transactions of the district headquarters.
4. **E-Panchayatas (Local Self-Government Units):** This programme was launched on January 26, 2005. It is executed through janpad panchayatas (local self-government units). Each janpad panchayata is given two computers that will be linked by satellite. The total cost of the project is over 9 million rupees, excluding the cost of software and satellite linking. It is sought to be an informative programme aimed at informing the rural people about the development and welfare schemes, and making available forms online. It is expected to be interactive in the future.
5. **Videoconferencing:** This programme was launched in January 2001. The heads of various government departments answer the ques-

tions asked by the common people through videoconferencing. It is being operated daily, and according to the officer in charge, 8 to 10 questions are asked daily.

6. **Feedback:** Most of the departments of the government are on the Web with the facility of a feedback system. Any citizen of the state can register any complaints or suggestions related to any of the schemes or programmes of the state government through the Internet. The complaint or suggestion is directly sent to the concerned department or official online. The status of the application or complaint can also be ascertained online.
7. **Wireless Loop-Line (WLL) Telephone:** Bharat Sanchar Nigam (the central agency providing telephone and Internet services all over India) has provided at least one phone to each village under this scheme with a 50% subsidy of the total bill. At some villages, Internet facility is also being started through this.

The ICT-related schemes listed attempt to make administration more citizen friendly in that earlier, obtaining these services involved visits to the offices concerned, often requiring a lot of time and effort. Making these schemes available on the Internet has also made it possible to obtain feedback from the public at the users' end, which was not easy earlier. The use of the Internet in administration in that sense is aimed at collapsing the distance between the officials and the public. In the Indian context, since before the ICT-based administrative schemes were introduced, it has been primarily men rather than women who often come into contact and interaction with officials (also mostly male) in administration. This is an activity in the public domain, which is traditionally male dominated, and is also considered largely the responsibility of the man in male-headed Indian families. The use of the Internet in administration could put the schemes within the reach of women without them having to move from their locales. However, this has not happened as assumed with the ICT-related policies and programmes, which aim at bringing administration within the reach of every citizen.

ICT Programmes and Women in Chattisgarh

Field surveys show that while it is generally assumed by policy makers (mainly male) that ICT policies and programmes will benefit men and women equally, the ground reality is that there is a vast difference in the availability, use, and access of ICT facilities for men and women. Hence, it is necessary to examine the gender perspective in the ICT policies and programmes. The ICT policies, programmes, and schemes in Chattisgarh seem to bypass the question of women's capacity building and empowerment. The impact of these policies at the user end for women is one of exclusion due to various reasons that need to be addressed urgently to avoid the digital gender divide superimposed on the already existing gender disadvantages for women arising from sociocultural factors (Nadamoto, 2003). Without a gender perspective, the low participation of women in accessing and using the ICT-based facilities may not be noticed. This is the case in the Chattisgarh region where even in urban areas, as compared to men, a very low number of women use the Internet-based facilities and services such as videoconferencing with public bodies; accessing Internet-based services like e-sangwari for obtaining records regarding births, deaths, or land; or using local government-information kiosks for obtaining information under the e-panchayata scheme. In fact, very few women have telephones registered in their own names. Similarly, in the educational sphere, there is low enrollment, retention, and visibility of women in ICT-related courses of study. Thus, in the Indian context, where women are already less visible in the public spheres due to sociocultural factors and men already dominate, ICT schemes are more available and accessible to men. This is also because ICTs have masculine connotations due to the traditionally larger presence of men in technological disciplines. Such is the picture in urban areas in Chattisgarh where more women are literate, are aware, and face comparatively less sociocultural constraints. Even if these programmes and facilities based on ICT are made available in the rural areas, women would still find it difficult to benefit from them due to the already existing limitations of a male-dominated society, especially those in areas dominated by the scheduled castes and tribes, who have been recognized as disadvantaged and who suffer from severe poverty, illiteracy, and backwardness, added to by the domination of patriarchal values, traditions, and attitudes.

While the state government of Chattisgarh is using the Internet in publicizing its various polices and programmes, advertising tenders and contracts, and making available the application forms of various schemes, in the absence of any capacity-building measures for women using ICT, at the operational level it is difficult for women to benefit from these schemes as they are unable to access the schemes due to various reasons located in the sociocultural milieu in which women are already disadvantaged. Traditionally, the households in India, whether in the urban or the rural sector, are male dominated, with the sphere of functions and activity related to the household clearly demarcated for women, which restricts their mobility in the public domain. This is reflected in women's choices of courses of study, the fact that very few are opting for and remaining in IT-related courses, and women's low presence in decision-making structures, even in urban areas where most of the ICT-related educational and training centres are found, where ICT-based programmes and schemes are being implemented, and where more women are educated and aware. In the rural areas, particularly in the backward areas and where socially disadvantaged sectors already exist, the digital divide accentuates the existing disparities both for men and women. For women who are situated in a rural backward area, it is doubly accentuated in that the well-intended ICT programmes and schemes do not reach them due to the urban bias in these programmes, and also because of the already existing gender disparity in the sociocultural milieu.

As ICT is becoming a popular and powerful tool for opinion formation through the dissemination of information, women's voices remain unheard while the men continue to dominate the common public discourse and opinion. The increased use of ICT in business is also benefiting mostly men as that sphere is also male dominated in India. In this sense, it could be said that the ICT-based services could further accentuate the dominance of men even though it may be intended to benefit all citizens. The ICT-based services, instead of being a means of empowerment and development of women, may in fact help in perpetuating the existing male-dominated gender patterns and biases in the society unless the issue of capacity building and empowerment of women is addressed.

FUTURE TRENDS

It is obvious from the foregoing analysis that without including the gender perspective into ICT policies and programmes, the potential benefits of ICTs may bypass girls and women, leading to a gender-based digital divide accentuating the preexisting gender imbalance. Access to and use of the new technologies may be directly linked to the social and economic development of women. In the Indian context, for instance, after the death of their husbands, without death certificates, many women face difficulties in getting the family pensions or rights over the properties of their husbands. Likewise, because of the lack of access to land records, it becomes difficult for women to sell or buy land without the help of a male. Similarly, as the videoconferencing facility is available only in the district headquarters, it is almost impossible for rural women to visit the site without the male members of their families. Thus, if women do not have access to and control over these technologies, it may result in their further marginalization from the economic, social, and political mainstream. Indian rural women comprise a social group that is already disadvantaged in the predigital society, and there is a threat that when it comes to the prospect of participating in and benefiting from the emerging information society, they will again find themselves doubly disadvantaged.

CONCLUSION

Technology has actually been historically and culturally construed as masculine. There has been a tendency toward the division of disciplines into masculine and feminine. For instance, arts, literature, languages, social sciences, and teachers' education are viewed as feminine. On the other hand, professional disciplines such as engineering, agriculture, medicine, commerce, and law have been traditionally perceived as masculine. More women are enrolled in the so-called feminine disciplines. As a result, women are conspicuously absent from the decision-making structure of ICT policy and programmes, resulting in the absence of the gender perspective in ICT policies and programmes.

Women's organizations, the office bearers of women's wings of different political parties, and other gender-focused organizations do not consider ICTs as a development concern or as an advocacy or political issue.

There is sometimes the problem of conceptual clarity regarding the modalities of gender mainstreaming among policy makers, those who implement them, development workers, and even among the academia. This lack of clarity or awareness, either conceptually or in operationalization, of gender mainstreaming and the resultant uncertainty have often led to nothing being done substantially apart from the mere use of some new words without much change in intentions or consequences for women

There is a often a common tendency in India among policy makers and among those who implement them to treat some areas as gender neutral, and this is the case with the ICT policies and programmes in Chattisgarh.

The patriarchal character of society and the well-entrenched patriarchal attitudes creep into the formulation and implementation of the ICT policies and programmes.

Unless a gender perspective is mainstreamed into policies and programmes, ICT is likely to remain a male-centric technology benefiting mostly men and depriving women, especially those who live in rural areas and those who are already socially disadvantaged as in Chattisgarh. There is an urgent need to ensure adequate measures in this direction to ascertain equal benefit and use of ICT for women.

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Policy Documents

- **Census of India:** http://www.censusindia.net/
- **IT Policy of Chattisgarh State of India:** http://chhattisgarh.nic.in/policy/IT%20Policy.pdf
- **Report of the Ministry of Communications and Information Technology, Government of India:** http://www.trai.gov.in/dld1.html
- **Social Infrastructure Document, Chattisgarh Government:** http://chhattisgarh.nic.in/opportunities/Social%20Infrastructure.pdf
- **State Vision Document of Chattisgarh State:** http://chhattisgarh.nic.in/vision/new/Chp%205%20-%20Unlocking%20Natural%20Wealth.pdf
- **Women's Policy of Chattisgarh State:** http://chhattisgarh.nic.in/wcd/womenpolicy.pdf

KEY TERMS

Digital Divide: The digital divide is defined as the disparity between individuals with and those without access to a computer and the Internet. The divide is applicable to all population sectors encompassing both adults and children, but the focus of much attention has been on segments of the population seen as underserved: people in low-income, rural, and multicultural areas, and women.

Gender: Gender refers to socially constructed rather than biologically determined roles of men and women, as well as the relationship between men and women in a given society at a specific time and place. These roles and relationships are not fixed but can and do change in the light of evolving needs and opportunities.

Gender Mainstreaming: Gender mainstreaming was defined by the United Nations Economic and Social Council in 1997 as a strategy for making women's as well as men's concerns and experiences an integral dimension of the design, implementation, monitoring, and evaluation of the policies and programmes in all political, economic, and social spheres so that women and men benefit equally, and inequality is not perpetuated.

Gender Neutral: Gender neutral means a policy or programme that purports to, or is assumed to, impact men and women in the same manner. (It could also mean a lack of gender awareness or even "gender blindness," i.e., not conscious about the ground reality about the position of women in a particular society.)

ICT Policy: An ICT policy is an integrated set of decisions, guidelines, laws, regulations, and other mechanisms geared to directing and shaping the production, acquisition, and use of ICTs. Because the ICT sector is heterogeneous, extending beyond traditional classifications of industrial or services sectors, and because the production and diffusion of ICTs are of equal importance, policies in the ICT sector intersect with a number of other areas of policy making: technology, media, industrial, and telecommunications policy, and so forth.

Primitive Tribes: The most backward groups of Indian tribes.

Scheduled Castes (SC): The socially disadvantaged section of the Indian society on the basis of the caste system, identified for affirmative action by the Indian constitution.

Scheduled Tribes (ST): The indigenous people of India, the forest dwellers commonly known as tribes, identified for affirmative action by the Indian constitution.

Gender and ICTs in Zambia

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INTRODUCTION

This article looks at gender equality combined with social and economic empowerment within the context of information communication technologies (ICTs). It discusses rhetoric surrounding the promotion of ICTs as tools for social and economic empowerment and subsequently challenges whether such rhetoric does mirror the real situation on the ground, especially as it relates to developing countries like Zambia. The main focus is underprivileged women, especially those in rural areas, and how access, or indeed the lack of it, to ICTs like the Internet and mobile phones does actually affect their daily existence.

BACKGROUND

There has been a great deal said and written about ICTs. A lot has been achieved and made possible through the accessibility, possession, and use of these ICTs. This includes learning, politics, shopping, and all kinds of businesses online, particularly in developed countries (Castells, 1996; Howard & Jones, 2004). In essence, what former United States President Bill Clinton had envisaged back in 1997 in his *State of the Union Address* has come to fruition and been mirrored by most developed countries. He stated,

the new promise of the global economy, the information age, unimagined new work, life-enhancing technology, all these are ours to seize. As the Internet becomes our new town square, a computer in every home, a teacher of all subjects, a connection to all cultures, this will no longer be a dream but a necessity. (Clinton, 1997)

Today, ICTs are indeed no longer a dream but a necessity in most parts of the developed world, hence their becoming part and parcel of everyday life to most. In this respect, ICTs are having a major impact on people's lives. However, there is ambivalence as to what kind of impact they might be having on developing countries (Shade, 2003), more so when it comes to the underprivileged rural populace who are usually women. For instance, despite acknowledging how new technologies are impacting most aspects of daily life, Mansell and Silverstone (1997) are cautious and advise to tread carefully as far as the technologies are concerned. They assert that "simplistic utopian or dystopian visions of the future provide us neither with an understanding of how these changes come about nor with an understanding of the longer-term implications" (p. 3). It would seem Mansell and Silverstone are concerned that despite the assumptions of social and economic benefits, there may be a lack of in-depth analysis of exactly how such benefits are possible.

Having stated that, one cannot ignore that a developing country like Zambia, situated in sub-Saharan Africa, with all its social and economic challenges, has also recognised the global influence and to an extent is experiencing the impact that these new ICTs are bringing. The country has advanced apace and is experiencing a permeation of ICTs, particularly in the form of mobile phones and the Internet. This permeation has meant a steady growth in their accessibility and usage, especially in urban areas. Since the introduction of these technologies in the 1990s, urban areas in Zambia, for instance, have seen a steady mushrooming of Internet cafes and an increase in mobile-phone usage. However, rural areas do not tell a similar story even though 65% of the country's slightly under 11-million-person population live in rural areas (Republic of Zambia Central Statistics Office, 2004). According to the statistics office, of the country's total population, 51% are women while 49% are men. The country's population also accounts for about 2 million households of which 66% are rural households. Of the 66% rural households, 68% are female-headed households whose survival depends on rural small-scale farming in addition to all the traditional stereotypical roles they have to attend to. For these rural dwellers, this has meant that the lack of a significant penetration of technology into their areas when pitted against the urban setting has deprived them of ICT accessibility and use. There are several reasons that can be attributed to this lack of penetration, some of which are that Internet and mobile-phone growth has been concentrated along the commercial line of rail where infrastructure exists. One clear impact of this permeation of ICTs, especially where mobile phones are concerned, has meant that mobile-phone ownership and usage has surpassed that of fixed landline ownership (Munsaka & Habeenzu, 2004).

This is in spite of the high price of acquiring and maintaining them because of the poor economic situation of the country. Other reasons why mobile-phone ownership exists more than that of fixed landline phones is because there is no bureaucracy in acquiring a mobile phone as there is when applying for a landline. In several cases, one has to wait for a while before a landline phone can be installed. Additionally, mobile-phone service providers are reaching and serving some parts of the country that were previously unreachable by the country's sole landline provider. For example, there are now approximately 450,000 mobile-phone subscribers compared to around 86,000 fixed landline subscribers. Adding on to that, there are around 13,000 Internet subscribers with an estimated 50,000 users (Communications Authority of Zambia, 2004). Evidently, there is substantial shared Internet use, particularly in public places like Internet cafes, universities, and even companies.

MAIN THRUST OF THE ARTICLE

Despite the continued growth, looking at the figures of subscribers and consequent users given above, the number is relatively small when compared to the country's population of slightly fewer than 11 million people. This is also bearing in mind that most of these subscribers and users are found in the urban areas of Zambia and are mostly men. Due to a lack of gender-disaggregated data, it is difficult to state how many women compared to men are Internet or mobile-phone subscribers or indeed users, but it is generally agreed that the greater number is biased toward men. Having carried out fieldwork in Zambia from November 2004 to March 2005, the author found that both men and women felt that men had more and easier access. The respondents also disclosed that more men than women used mobile phones and the Internet. To get this information, the author conducted one-to-one interviews with, among others, policy makers, nongovernmental organisations, and underprivileged men and women, especially those in the rural areas. There were also 390 questionnaires administered to 209 men and 181 women, and focus-group discussions and observations.

The Zambian society is very much a patriarchal, hegemonic, and hierarchical society where men have more advantages than women and where inequality between both genders seems to be the norm. It therefore came as no surprise that respondents confirmed that men were more advantaged when it came to ICT accessibility and use. Some of the reasons given were that men were more financially stable, were more educated, had better access to employment, and generally had more time to access and use the technologies while women, aside from their lower educational attainments, had additional household and family chores to do. Supporting these findings, official government statistics confirm that in Zambia there are more men than women receiving higher education. Also, there are more women who are unemployed than there are men (Republic of Zambia Central Statistics Office, 2004). The government in effect accepts that there is a problem of inequality when it comes to accessing and using ICTs. In its 2004 Strategic Plan of Action for the National Gender Policy, the Zambian government indicates that women are unfairly and unequally represented in the media, that women have no say in communication, and that girls and women lag behind in engaging with science and technology subjects (Republic of Zambia Gender in Development Division, 2004). In this regard, the gender imbalance of technology is not surprising, as several studies have shown (Cockburn & Ormrod, 1993; Wajcman, 1991). These studies indicate the gendered aspects of technology and also show that technology is not neutral. Faulkner and Arnold (1985) summed this aspect when they pointed out that "ultimately, the power of modern technology emanates from the powerful in our society, and reinforces their power. As in other areas of our patriarchal and capitalist society, those with power are predominately male" (p. 1).

Although there are seemingly a minimal number of ICT users in a developing country like Zambia and the obvious difficulties and problems of gender inequality in the use and accessibility of ICTs, scholars like Harcourt (1999) and Negroponte (1995) express optimistic views of the new technologies. Negroponte enthuses that the digital age can be "harmonizing and empowering" (p. 229). One can take it that such optimistic views seem to imply that the new technologies may eventually be able to sustain both social and economic development. This optimism is seemingly shared by policy makers' rhetoric at the local and international levels. Policy makers have indicated and consequently advocated for the use of ICTs in order to realise social and economic empowerment, especially for women who are the marginalised gender. For instance, at the local level, in its draft national ICT policy, the Zambian government indicates that its mission is "to enhance and accelerate sustainable economic growth and social development through the provision of affordable and universally accessible ICTs" (Republic of Zambia, 2004, p. 5). In continuing further, the policy states the need to "increase participation and empowerment opportunities for youth and women in national development through ICTs" (p. 17). At the international level, the United Nations' optimism of ICTs' potential in achieving gender equality as well as harnessing social and economic development is evident in its World Summit of the Information Society (WSIS) Declaration of Principles. Part of the declaration states that the "challenge is to harness the potential of information and communication technology to promote development goals; the eradication of extreme poverty and hunger; promotion of gender equality and empowerment of women" (United Nations, 2003, p. 1).

The question that needs to be asked then is whether all this rhetoric mirrors actual reality on the ground. Can what ICTs have done in the West be done in the developing world? Are there signs that developing countries like Zambia are getting to the level where developed countries have gotten to in terms of ICT innovation, accessibility, and use, or is this just mere rhetoric such that there is no change, especially for the underprivileged rural women?

The author is by no means trying to undermine the importance of ICTs because there is no ignoring the positive potentials they bring. However, the point the author is trying to assess is to what extent this potential is. By having access to these ICTs, is there a difference being achieved in terms of what may seemingly be more pressing issues to communities such as inadequate water, food, shelter, or education? Are ICTs making a major difference, or any difference at all for that matter, to a woman who is expected to wake up at the break of dawn to gather firewood and make fire to prepare bathing water and food for her husband to find ready when he wakes up? After all this, she then has to proceed to the field to cultivate her crops and then come back to prepare food while the husband rests and waits for his wife to tell him food is ready. These may seem simplistic examples, but nonetheless, these are situations most women in the rural parts of Zambia have to contend with everyday of their lives. No doubt, when they are lucky enough to have access to ICTs like mobile phones, they do take advantage of them. However, the cardinal question still remains, which is whether there is appreciable improvement to their everyday existence.

The prospects for social and economic benefits may promise the alleviation of problems like poverty and hunger that most developing countries are experiencing, but the idea that ICTs can be catalysts for the alleviation of such problems by simply being accessible seems both too simplistic and idealistic at the very least. It is simplistic and idealistic because one would argue that there is much more to ICTs and development than mere access. The digital divide, for example, shows that old, traditional social inequalities still persist. These include social inequalities between rich and poor countries, between the rich and poor in developing countries, as well as those between men and women. The dichotomies of accessibility and inaccessibility, rich and poor, and to have and have not seem to persist constantly. This shows that the traditional social hierarchical power structures could be more divisive in the adoption of ICTs. The problem of such dichotomies is not only in developing countries, but in the developed world as well (Evans, 2004), though the scale may differ. These inequalities and/or disadvantages then occur and intersect within other social categories of sex, gender, class, and even race (Servon, 2002). This makes access, as a route to empowerment and development, seem somewhat more complex than often assumed. As such, it is perhaps not surprising that commentators like Mansell and Silverstone (1997), as cited earlier, may seem a bit sceptical of views that ICTs might result in social and economic development, especially for socially disadvantaged groups like most women in Zambia.

The rhetoric of information as being a catalyst for social and economic development may be right to a certain extent, but mere access to ICTs will not automatically be empowering. Perhaps this can only happen when one has the privilege of being privy to other factors of life such as shelter, food, knowledge to understand the importance and use of such ICTs, justice, and capacity in terms of capital to be able to change with the dynamism with which technologies come and go. That may also explain why there is just a fraction of users in Zambia who have access: Those are the privileged few that can afford to have access. Additionally, in this day and age, information is becoming more and more commercial. As such, for those without the means to purchase it, information will continue being unevenly distributed and hence unhelpful in bringing empowerment (Lax, 2001). Thus far, there is an obvious hindrance and exclusion to the benefits that ICTs can bring to those who cannot afford to have them. On the other hand, there is a lot of truth in the point that with ICTs have come a whole wealth of information previously thought inaccessible by many people. One only has to go to a search engine and type in a request, and a flurry of information pops up. However, there are still evident hierarchies in what type of information one can access, who can access it, and to a large extent at what cost.

There is evidence as witnessed by the author during her fieldwork that the position of most rural and underprivileged women in Zambia is not really changing due to the use of ICTs. If anything, their stereotypical subordinate situation might be more glaringly obvious. Also, the economic change might not be that significant to warrant an economic emancipation. During the fieldwork, some women expressed concern about the new ICTs, particularly the mobile phone, because the mobile phone was actually ruining their marriages or partnerships. One woman pointed out that she had to sell her mobile phone because it was bringing a lot of noise and misunderstanding between herself and her husband. She stated that her husband became paranoid and started suspecting her of extramarital activities. On the other hand, she did not understand why her husband had to go outside to answer his mobile phone whenever it seemed there was a woman on the other end. When confronted, her husband either became uncompromising or said it was just a mere male friend when in fact it was a female's voice she would usually hear. Unfortunately, she could not do anything about it as her husband was the head of the house and was therefore superior to her.

This example shows that in certain situations, there is no negotiating power; women are in a constant battle where power is concerned and often do not have it. Their position is actually reinforced and in some cases made worse through the use of ICTs. To the question of whether the Internet or mobile phones were empowering them, the common response of most women and men indicated that their daily existence had not changed, but they were merely able to cut down on travel costs. They also disclosed that it was quicker to get in touch with either friends or relatives, or to check up on debtors. However, in the same vein, most pointed out that the cost of maintaining their mobiles or using the Internet when they could was too expensive. One female respondent pointedly stated the following:

Why would I want to use the Internet or spend money buying a mobile phone when I have to make sure there is food on the table for my family? Will the Internet feed me or give me food to take to my kids? I think not!

For those who had mobile phones, how much their access and use of ICTs measured to their everyday struggles was quite difficult to quantify. If anything, they felt the changes were too minimal to point to as success stories. The established unequal gender differentials were still very much in existence and were showing no obvious signs of improving. It was also clear that there were still a lot of problems women were experiencing with or without the new ICTs.

FUTURE TRENDS

While there has been a plethora of research on gender and ICTs, particularly in developed countries, there seems to be very little research done in developing countries like Zambia that has challenged policy makers' rhetoric. What seem evident are anecdotes on how empowering ICTs are and how they can bring gender equality as well as social and economic emancipation. More critical analysis into such assertions is of utmost importance.

CONCLUSION

In more ways than one, ICTs have changed the world for the better. However, for most underprivileged people, especially women in rural areas, the opposite may be true. It would seem that such groups of people do not attach a great deal of importance to ICTs, but rather to immediate needs of food, shelter, health, and education. Perhaps they also feel that ICTs are not necessarily the only answer to their everyday lives and that there may be other ways and means with which to engage in order to answer social and economic problems. As the traditional stereotype relations between men and women continue to persist, a gender balance is also questionable when it comes to engaging with ICTs.

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KEY TERMS

Developing Countries: Unindustrialised countries with low per-capita incomes.

Gender Balance: Equal opportunities for both genders with respect for differences.

Gender Differentials: Different social constructions between men and women in which women are usually treated unfairly in, for example, social and economic settings.

ICTs: Information communication technologies like mobile phones and the Internet.

Rhetoric: Effective and persuasive talk about how good ICTs are than actually may be.

Rural Poor: People living in areas far away from large cities often in thatched huts with inadequate amenities like electricity and transport.

WSIS: The World Summit on the Information Society is a United Nations body whose purpose is to ensure that benefits in areas like e-commerce, e-governance, e-health, education, literacy, and gender equality are possible for all.

Gender and Information Technology in Rural Bangladesh

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INTRODUCTION

Information technology (IT) is transforming our personal, social, cultural, economic and political lives. But women in developing countries do not have equal access to knowledge, due to the fact that they do not have access to the new technologies at the same level as western European women. They need to understand the significance of new technologies and use them in relevant fields. IT can offer immense opportunities for virtually all girls and women in developing countries, including poor women living in rural areas.

Developing countries like Bangladesh are usually seen as problematic hosts for ITs because most developing regions of the country lack economic resources and indigenous techno-scientific capabilities to develop and deploy IT infrastructures. The regions also tend not to make the best use of opportunities of technology transfer.

The wider adoption of IT in the 1990s promised a globally connected community of equal participants in electronic networks. The Internet has enabled people to communicate regardless of race, sex, physical ability, location and social background (GVU, 1998). IT now offers access to a huge pool of information. The Internet enables worldwide communication that is cheaper, faster and more flexible than older media like e-mail, telephone, telex or fax.

BACKGROUND

In early 2000, an initiative was taken to develop a small river island (char) of Bangladesh through establishment of a resource centre named Indigenous Science and Technology at Ikrail (ISTI), and using IT as the main vehicle for development. IT is a livelihood to many women of the developed countries but is almost unknown to the women and girls of the river island.

Women in Bangladesh are seen in the frontlines to fight against hunger, poverty and environmental degradation. Because of lack of awareness about the benefits of IT, they cannot raise their problems for solution to the proper authority. IT can benefit women in various ways and can facilitate their participation in different sectors and regions. It can provide information women need to improve their own well-being and that of their families. The introduction of computers in offices can improve the quality of work and scope for women in data entry, analysis, programming, clerical and administrative occupations in Bangladesh. IT could allow them to exchange views, opinions and information with women of other regions and countries.

The situation for rural populations in many regions of the world is characterized by geographical distance from urban centres that offer employment and income, education, cultural events and public services. IT bears the potential to improve the situation of rural people in several ways. For example, it is agreed that early diagnosis of medical issues can prevent many casualties. Once a patient comes to the health centre, using various sensors, information can be collected and communicated to an expert at hospitals in the district headquarters. The primary healthcare centre could be located in a rural area or in a mobile centre installed in a van.

IT offers access to information and extension, to education and training communication and networking in online discussions. IT also offers access to employment and income.

Infrastructural Problems

Poor healthcare can result from a lack of good information. Establishing reliable communications may be one of the most important priorities for improving healthcare and education. Many rural areas in the globe have no or outdated telephone lines that can transmit Internet-based data. The lack of infrastructure can be overcome by wireless technology (e.g., radio modems). Mobile telecentres can be a solution for the target group.

HEALTHCARE IT PROJECT

A significant number of women scientists, researchers and technologists work in rural Bangladesh. They are disadvantaged and traditionally underrepresented in most respects. Their knowledge and skills are unrecognized, underused and under valued. As such, they are in greater need of upgrading their skills, especially in the fast advancing world of information and communication technologies (ICTs), which might enable them to connect their global colleagues, sources of information and global knowledge wherever they may be located.

A survey conducted in early 2000 among 515 women professionals of various disciplines spanning life sciences, social sciences, physical sciences, mineral sciences, engineering, technologies and medical sciences identified that they are almost illiterate in IT, although they are well qualified and experienced in their respective fields. At the first step, the survey was conducted over the senior professors of the public and private universities, scientists of the Bangladesh Council of Scientific and Industrial Research (BCSIR), researchers of institutes of forest research, housing research, fuel research, jute research and water resource and geological research.

They have very poor knowledge about the power and benefit of IT. This trend was found true at all levels of educational backgrounds. The survey revealed that the illiteracy rate in IT among the medical doctors are high, because the doctors are normally resistant to new technology, particularly IT.

To reach the benefit to the rural communities, participants for IT training were selected from among applicants spanning all sectors, giving priority to the rural community. The representation covered various national economy, especially health, environment, education, natural resources (mineral resources), energy, industry, agriculture, fisheries and forestry. Special care was taken in selection of participants so that the maximum number of organizations and individuals would benefit from the program. Training programs on IT for the duration of 2 weeks were organized in different private universities at a certain interval with 20 participants in each phase. The programs were initially organized at the capital city, and later, the programs were arranged at the regional institutes and universities. The regional programs were mainly organized for the medical doctors working in the local hospitals, clinics, medical colleges and universities. Selection of participants from the women medical doctors was really a tough job. Neither the medical doctors nor their family members wanted to spare 2 weeks for attending a training course that they feel are good for their children, not for the doctors. Strategies were adopted to attract the medical doctors. As soon as they realized the importance of IT, they invested more of their valuable time to learn further applications. Ninety-two percent of the trained medical doctors were found to utilize their gained knowledge intelligently in their respective fields. The result was obtained from the follow-up visit by the project staff.

FUTURE TRENDS

Bangladesh is a country of rivers that create islands (chars) of different shapes and sizes. They are created because of river erosion. The ISTI resource centre is located in one such island. The island is circular in shape and its area varies from 20 to 30 square kilometers, depending on seasons. Approximately 15,000 people live in the island community. The people depend on local cultivation for survival. Their average monthly earning is $40 (United States dollars). The area is fertile and rice, wheat, peanut, jute, sugarcane, and different types of vegetables and fruits are common. All work is performed manually. The people are deprived of basic infrastructure. There is no electricity, phone system or sanitation. The only source of water is contaminated with arsenic. There are no health clinics or doctors in the area. Many adults are illiterate, and curable diseases, such as cholera, malaria and tuberculosis, are pervasive.

The ISTI resource centre has been established with the objective of developing this isolated region with proper education, empowering local people with relevant technology, particularly IT, and providing them with medical facilities using modern techniques (such as telemedicine and telehealth care). The ISTI resource centre, equipped with basic medical test equipment like stethoscopes, blood pressure meters and blood testing chemicals, and connected with a hospital located in the district town, might save lives of many women and girls. Just a computer with a modem connected with wireless local loop (WLL) help solve most of the serious problems of local women by the women medical doctors empowered with IT. The ISTI resource centre is working as role model for several million disadvantaged women living in the river islands of Bangladesh.

CONCLUSION

This training program has been particularly suitable and effective for relatively marginalized groups and remote communities in a developing country because of its low cost and the use of local organizers and trainers, courses especially designed to meet the participants' needs and in situ follow up. The direct involvement in the courses of senior policy makers, employers and local experts has proven to be absolutely crucial in gaining support for the continuation and expansion of the course and, perhaps more importantly, effecting attitude change to women's roles and capabilities in science and medicine. This was underlined by the increasing cooperation extended by them to the project team during preparation and execution of the project. The outcome of the whole training has been impressive. Participants' value to the work place has increased, some attained promotions and some changed careers.

The final evaluation report shows that most women medical doctors and other health-related professionals empowered with IT have expressed their opinions that every medical doctor must attend relevant technology—particularly IT—courses if they want to enhance their services and maintain their personal secrecies. Some mentioned that IT is a magic and all-pervasive tool.

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KEY TERMS

Information and Communication Technology (ICT): ICT covers computing, electronics and telecommunications.

Medical Professionals: Medical doctors and scientists in health-related subjects, such as nutrition, bio-chemistry, psychology and so forth.

Researchers: Graduates and post graduates engaged in research activities.

Scientists: Science graduate with some research experience in scientific fields.

Technologists: Engineers and scientists with experience in hardware.

University: A university is characterized by a wide variety of teaching and research, especially at a higher level, that maintains, advances, disseminates and assists the application of knowledge, develops intellectual independence and promotes community learning.

Gender and IT in the Concept of Sustainability

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THE GLOBAL DIGITAL DIVIDE

New information and communication technologies are radically transforming the way that information and knowledge are disseminated and shared around the world. The digital divide between rich and poor countries is still persisting: more than 70% of the world's Internet users are based in Europe and North America, where—in addition—more than 90% of the data on Africa are stored. Similar gaps persist between urban and rural areas and between men and women, especially in developing countries. Rural women usually have less access than men to information and new technologies (Huyer & Mitter 2003). Lack of information and access to education related to IT also limits women's influence in their communities and their ability to participate in decision-making. When assessing the opportunities and risks of new technologies, it is essential to give attention to gender differences and to ensuring that women's voice is heard so that technological developments can be sustainable in the way that best prevents them from increasing inequalities. Particularly gender factors are crucial to develop a sustainable concept of IT evolution. Our aim in this article is to show how the concept of gender and IT can be integrated in a wider conceptual framework of sustainability. First, we will explain the concept of digital divide from a global perspective and the importance to understand the gender dimension within this conceptualization.

Concerns about the disparities between industrialized and developing countries, especially with respect to Internet access and use, have touched off a worldwide debate about the existence of a global digital divide. From a domestic perspective at a national level or even at a regional level thinking about the European Union for instance, the term digital divide has shown to have powerful symbolic weight, and hence to be a useful tool with which to mobilize political support for government programmes designed to bridge the gaps between so called "information haves" and "information have-nots." The OECD defines the "digital divide" as "…the gap between individuals, households, business and geographic areas at different socio-economic levels with regard both to their opportunities to access information and communication technologies (ICTs) and to their use of the Internet for a wide variety of activities. The digital divide reflects various differences among and within countries." (OECD, 2001, p. 5). Access to information and communication technologies is considered as the first stage to become an "information have." However, access is not limited to the infrastructures: an important factor contributing to the digital divide is the extended and hegemonic use of English as access language in the Internet. This is one of the reasons for instance, why the Hispanics in the USA a lower access to the Internet show as Wilhelm (2000) argues. Moreover, even among "information haves" or in other words, among those having access to information through information technologies we can observe digital gaps. DiMaggio and Hargittai (2001, p. 4) refers for instance to the ability to evaluate the quality of information: "By 'digital divide,' we refer to inequalities in access to the Internet, extent of use, knowledge of search strategies, quality of technical connections and social support, ability to evaluate the quality of information, and diversity of uses." This aspect is particularly related to the inequalities according to the educational level of the "information haves." Furthermore, when carried to the international level, the term "digital divide" arguably misconstrues the issue and is unduly pessimistic. For example, the term directs our attention to relative inequalities in the distribution of information age resources, when what really matters to the quality of life in a given country is its absolute level of resources and the efficacy of the institutional order in redistribution and social justice. Qureshi (2005, p. 1) refers to the results of a recent study about the digital divide showing that "it is access to information, services, and expertise through access to the network, combined with ICT skills that contribute to economic growth and a decrease in this gap." Instead of fixating on the existence of a divide, it would be far better to focus our attention on the "global digital opportunity," because that is what really confronts us today, an unprecedented opportunity to move swiftly up the path towards global digital development. From a gender perspective, it is important to improve the access of women, particularly women in underdeveloped countries and rural areas to knowledge and information through IT, but it is also important that women participate in the design and production of IT. We argue that the digital divide must consider also the gap regarding IT shaping. Shaping IT means nowadays in much extent shaping society and nature and thus we plaid for a concept of sustainable information society with a participatory approach that allows the integration of excluded perspectives and moving beyond consumerism fixations taking local voices and the co-evolution of nature and society as a point of departure. Particularly women's perspectives excluded in great extent through gendering processes must be taken into account as they reinforce other embedded inequalities factors such as education or age. Understanding gendering processes within the shaping of IT and society is crucial in the concept of sustainable information society. However, IT development constitutes also a complex co-evolution of nature and society in different world regions. Particularly sustainability scholars have attempted to define these both basic co-interacting spaces. In the next section, we show an overview of the basic assumptions of sustainability that have lead to a more focused concept of sustainable information society.

THE CONCEPT OF SUSTAINABILITY AND THE INFORMATION SOCIETY

The concept of sustainability addresses basically a balance of society-economy-environment interactions. It assumes that there exist limits to which the earth's ecosystems can sustain disruption, without, in turn, causing injury to human health, social and cultural systems, and economic interests. The concept of sustainability thus attempts to define both, environmental conditions contributing to a healthy and stable human existence, as well as activities that while not limiting our evolution to more sophisticated and justice living conditions, can help us to create such conditions. However, moralistic and normative issues of intergenerational and global equity drive to some extent sustainability discourses. According to the definition of the World Bank Institute, global equity refers to equal opportunity for livelihood and development across the world while intergenerational equity focuses on the balance of potential and opportunities for livelihood and development between future and current generations (World Bank Institute, 2000). This assumption represents a common perspective among scholars over the past two decades, although the diversity of sustainability theories.

Rachel Carson's book "Silent Spring" (1962) constitutes the base of what we call today the sustainable development movement (International Institute for Sustainable Development, 2002) which Garret Hardin (1968) in his classical article "Tragedy of the Commons" developed. Since then many different definitions of sustainability have been developed (Neumayer, 1999; Rees, 1995). However, most scholars refer to the 1987 Brundtland Commission definition of sustainability as a departure point: "Humanity has the ability to make development sustainable to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs." (Brundtland 1987, p. 41)[1] This definition of sustainability presented by the Brundtland Commission (WCED, 1987) implies a subdivision into social, ecological, and economic dimensions. This tridimensional conceptualization of sustainability has been however extended including additional dimensions, as it is the case in the concept of Jacob (1996), who departing from the theory of science defines the different aspects of sustainability as being social, economic, political, and cultural. Other authors plaid also for the consideration of cultural dimensions (Kuhlen, 2004) or include an institutional dimension (Schneidewind, 2001) in the original triangle of sustainability. A related subdivision is used at the Wuppertal Institute, who has formulated a "Prism of Sustainability" (Spangenberg & Bonniot, 1998) with the three corners of the triangular base representing social, economic, and environmental imperatives. The top of the prism represents the institutional imperative and these four imperatives carry equal importance for a sustainable development. Further, the prism functions as a foundation for the development of indicators for sustainable development.

Looking beyond the point marked by the Brundtland Report and trying to give an overview of the general perspectives in the literature on sustainability, two basic points of view—"weak sustainability" and "strong sustainability" can be distinguished. Both these perspectives are focused on the preservation of environmental capital and seem to be in opposition to each other. The difference between these perspectives remains primarily in their assumptions about the nature of the natural capital. The weak sustainability (WS) perspective assumes natural capital to be substitutable (Beatley & Manning, 1997; Becker & Jahn, 1999; Pearce, Barbier, & Markandya, 1990; Sharma, 2000, 2003; WCED, 1987; World Bank Institute, 2000) through investment in new production forms and consumer goods, from the utilization of non-renewable resources to research on renewable resources. Neumayer (1999) thus calls this perspective the "substitutability paradigm" and refers to the concept of genuine savings of Hamilton (1994) as the green net national product. Genuine Savings Net is understood as the net national product augmented for investments in and deducted for deterioration of natural as well as other possible forms of capital. The strong sustainability (SS) perspective, on the other hand, conceptualizes natural capital as non-substitutable good (Brown, Kane, & Roodman, 1994; Daly, 1996; Ehrlich, 1986; Neumayer, 1999; Pearce et al., 1990). Natural capital consists from this point of view of renewable and non-renewable resources. Thus, scholars assuming strong sustainability approach suggest to stop the consumption of non-renewable resources and to maintain a rate of consumption of renewable resources that is less than the rate of regeneration of the renewable source for all time periods. Accordingly, to this concept Strong Sustainability is called the "non-substitutability paradigm." (Neumayer, 1999). We can also define these approaches as "techno-centrist" or "eco-centrist" (Eblinghaus & Stickler, 1996). The success of the strong sustainability strategy depends on the satisfaction of key institutional, political, and ethical requirements which include participation and inclusion of stakeholders in decision-making. Gender mainstreaming plays here a crucial role.

In 1973, Strong introduced the concept of eco-development that Sachs (1980) and later on Glaeser (1984) upgraded. These authors attempted to find convergences between ecological and development principles trying to define development paths for a balanced and qualitative growth instead of an "eco-centric zero-growth" in a similar way as the Brundtland Report in 1987. Particularly important at this time was the Chernobil accident in 1986. This catastrophe represents a crucial point leading to reflection about the risks of technological development. From a sociological point of view Luhmann (1987) and Beck (1986) represent some the most influent authors referring to the ecological risks in contemporary societies and to the interaction between society and nature. Institutions play a crucial role at this point in order to reach the resonance and reflexivity needed for a dialog between the self-referenced sub-systems of contemporary societies. The neo-institutional paradigm emphasizes since the eighties the necessity of social institutions as a fundament of social interaction. Sustainability as defined by the Rio conference is such a normative concept, which adds to projects of social development visions, and thus the possibility of shared goal orientation. Different types of social actions (e.g., eco-profit in economic sub-systems) can be subsumed under this culturally accepted goal. Well running projects of AGENDA 21 processes can be found now nearly everywhere in the world and illustrate, that by means of orientation at environmental norms different groups and parties of a wide range of interests can co-operate. Regional development programs include sustainability as well as participation of the civil society in its programs.

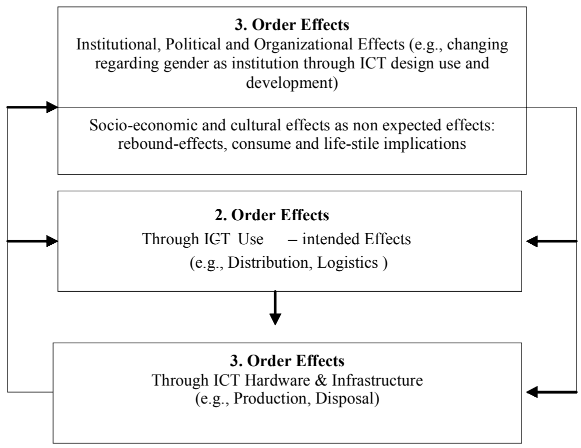
Under the concept of moral obligation, also the tension between regionalism and universalism can be stabilised (think global, act local). The recovery of the local in view of the global is one of the interesting points for regional social development.[2] Also the tension between utilitarism and altruism as different action orientations can be brought together in a regional perspective.

Taking these ideas as basis Schneidewind (2001) attempts to create a model of sustainable information society. Schneidewind (2001) distinguishes primarily between two dimensions considering the ecological implications of information technologies. Firstly, the effects of IT infrastructures (energy consume, electronic garbage, toxic products) and secondly the effects derivate of IT use, especially internet. Particularly this second dimension is very difficult to measure. Schneidewind considers that a socio-ecologic approach is needed here in order to measure the change in social structures and institutions as an effect of IT use. He distinguishes two interacting levels of research: First level effects (economic-structural effects or rebound-effects) and Second level effects (institutional-structural effects; for instance new governance structures). However, especially important in this approach is the conceptualization of sustainable information society as a developing path for institutions and organisations enabled through information and communication technologies. This means that information and communications technologies can help to reach new sustainable organisational and institutional forms through which side effects from a social, economical, or ecological perspective are controllable. Moreover, information and communication technologies can concretely help to improve the reflexivity of decision processes, participation, self organisation forms and justice forms of conflict regulation and balance of interests. Ruiz Ben and Quack (2004) have enhanced this model introducing a gender perspective as a transversal category. In the next section, we give a brief overview about the discourse on gender and sustainability and afterwards in a concluding chapter we will explain the adapted model of Ruiz Ben and Quack (2004).

GENDER IN THE CONCEPT OF SUSTAINABLE INFORMATION SOCIETY

The discourse on gender and sustainability has been marked in its origin by the earlier eco-feminism. Francoise d'Eaubonne first used the term ecofeminism in her l974 book *Le Féminisme ou la mort*. The eco-feminism has since then been associated with the idea that "women", animals as well as "nature" share a subordinate and instrumental relationship to hegemonic, mainstream men in global patriarchal practices. Moreover, they are embedded into patterns, attitudes, and institutions of male domination. More concretely, according to Kailo (2003) Davies describes ecofeminism as stressing the importance of a holistic approach to living, with holism implying that the planet is a single interacting ecosystem and that all forms of life are interdependent (Davies, p. 1988, p. 4-5). Another important aspect in Davies' theory is the principle of non-hierarchical systems following from the holistic emphasis on interdependence and leading to the complementarities and equal status of all parts of the ecosystem (Davies, 1988, p. 5). From the perspective of ecofeminism, hybridity, or challenges to the unified anthropocentric subjectivity as such does not represent a value, but the way the intermingling of humans and animals can lead to more respectful socio-ecological relations. As Merchant (1980) as one of the pioneer in this field has shown, liberal, Marxist, post-modern, cultural and socialist eco-feminists have applied the above principles with divergent emphasis and strategies for change. Merchant (1980) argues that nature was conceived on an organic model as a benevolent female and a nurturing mother before the scientific revolution. Afterwards nature was conceived from the perspective of mechanistic ideals as machine, inert, dead. The move from the organic to the mechanistic ideal enabled a justified exploitation of the earth. This mechanistic perspective replaced an older, organic worldview, which provided gendered moral restraints on how to deal with nature. Davies' work lead to the assumption of an existing connexion between the domination of the environment with economic purposes, the domination of unprivileged social groups, and a patriarchal hegemony. Plumwood (1991) argues that rationalism is the key to understand woman-nature connections in the Western world. Rationalism resides in a long-standing philosophical tradition assuming the premises of dichotomization (e.g., human-nature, masculine-feminine, reason-emotion, spirit-body) and privileging the human self as masculine and centred around rationality and excluding its contraries (especially characterized as feminine, animal, or natural). A more essentialist perspective brings Shiva (1988) in the eco-feminism discourse. This author emphasizes the ethical aspects of women as "care-takers" with a privileged natural role to nature. Feminism environmentalists have criticized this assumptions and plaid for a pragmatic and more materialistic

Figure 1. Overview of the effect-levels for the analysis of IT from the perspective of sustainability (Based on Ruiz Ben & Quack, 2004 on the basis of OECD, 2001; Fichter, 2001; Schneidewind, 2001)



approach. Thus Argawal (1992) for instance refers to the importance of customs, and social structures in defining women´s relationship to environment. Braidotti (1999) suggests updating the discourse of sustainability from a perspective of the:

historically marginalized others (woman, the ethnic other and the natural environment) as the signs of a crisis of modernity and of representation open up a multi-layered field, encompassing:

- *On a political level, coalition building among heterogeneous actors, the renegotiation of identity and a refiguration of subjectivity as a crucial task for social philosophy. Drawing on insights from feminist theory, a transformative trajectory built in the discourse of on sustainability might be discussed in terms of "differences within*
- *On an epistemological level, a re-examination of sciences, the dominant model of Western representation, implying also an outlook on how the ethnocentric and masculinist bias of science might be overcome.*

Taking this perspective as a departure point, we suggest integrating the concept of gender as a queer category in the analysis model of sustainable information society as we explain in the next concluding chapter.

CONCLUSION

For the analysis model of sustainable information society Braidotti's view can be considered as a queer perspective enhancing the previously cited prism of sustainability in which institutions play a crucial role. In our model we understand gender as a social institution (see Martin, 2004) that as such can change through reflexivity or in other words and putting the concept in the context of IT, through a long-term analysis of the implications of the gender regime in IT innovations.

Thus, we propose the model in Figure 1.

In Figure 1, we can see the interaction between the different levels for the analysis of IT use from the perspective of sustainability considering gender at the third level of analysis. For this approach we need a transdisciplinary view. Sociological and ethnological methods addressing the analysis of gender in its symbolical and structural dimensionality as well as methodologies from consume and economic research and also life-cycle analysis, environmental performance evaluation, etc. must be combined. Thus, also a dialog among disciplines and a reflexivity at the level of the own researches is required. Which also constitutes a crucial step for shaping IT innovations from a sustainable and participatory perspective.

G

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KEY TERMS

Digital Divide: Inequalities between individuals, households, business and geographic areas at different socio-economic and cultural levels with regard to their opportunities to access information and communication technologies (ICTs) and especially the Internet, to the quality of the related resources, to their extent of use and the ability to evaluate the quality of the information and the potential for a wide diversity of uses.

Eco-Development: Harmonization of social and economic objectives with ecologically sound management, in a spirit of solidarity with future generations.

Eco-Feminism: movement that acknowledges a relationship between sexism, racism as well as other social inequalities and the domination of nature.

Strong Sustainability: Perspective (also called "non-sustainability paradigm") conceptualizes natural capital as non-substitutable good.

Sustainability: Ability to make development sustainable to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs.

Sustainable Information Society: sustainable developing path for institutions and organisations enabled through information and communication technologies.

Weak Sustainability Perspective: Assumes natural capital to be substitutable through investment in new production forms and consumer goods, from the utilization of non-renewable resources to research on renewable resources.

ENDNOTES

1 http://www.are.admin.ch/imperia/md/content/are/nachhaltigeentwicklung/brundtland_bericht.pdf

2 Rolf Lindner, Die Wiederkehr des Regionalen. Über neue Formen kultureller Identität, Frankfurt a.M. /New York 1994.

Gender and IT Professional Work Identity

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We need work, and as adults, we find identity and are identified by the work we do. If this is true then we must be very careful about what we choose to do for a living, for what we do is what we will become. (Gini, 1998, p. 707)

Individuals are in a constant state of becoming, of moving between and through various roles and their attached identities and relationships. (Ashforth, 2001, p. 3)

INTRODUCTION

Our daily work is intrinsically tied to our personal image (Alvesson, 2001; Dahlberg, 2004; Gini, 1998). This is particularly true for Americans, since our personal identity is defined by what we do and how we accomplish our tasks (Alvesson, 2001; Gini, 1998). For example, in social gatherings, after learning a person's name, the first piece of information requested is, "What do you do?" Job references provide a wealth of information regarding income, work habits, tasks, levels of responsibility, educational background, etc. Often, the generalizations that people make from this small bit of information are materially incorrect, but that is not usually considered relevant in the social context. It is more important for society to construct a category for placement of the person. In the literature on motivation, Steers and Porter (1991) posit that work primarily impacts individuals in four ways. First, people typically expect to be compensated or rewarded for their efforts (e.g., salary and bonuses). Second, work provides an opportunity for people to interact socially (with some obvious exceptions). Third, employment may influence people's status in the community, outside of the work environment. This is most evident in the case of corporate executives and various professionals. Fourth, "from a psychological standpoint, [work] can be an important source of *identity*, self-esteem, and self-actualization," (Steers & Porter, 1991, p. 574, italics added). Basically, people are internalizing their work experiences. In other words, when workers look in the mirror, what do they see? How would they classify themselves? To what group do they personally relate? Specifically, is there homogeneity in the work identities of IT professionals?

The purpose of this article is to present an overview of the impact of gender on the developmental process of work identity creation in the IT field and its impact on job-related outcomes. This article begins with a general description of work identity in the IT profession, including a review of current literature on the formation of work identities. The next section summarizes research findings on gender from a larger study on work identity in the technology field, providing insights into the effect of gender on job satisfaction and intent to leave. The future trends and conclusion sections provide suggestions and managerial and academic implications.

BACKGROUND

Work identity is not a new concept. However, its application is dynamic and context dependent (Darais, Nelson, Rice, & Buche, 2004; Sveningsson & Alvesson, 2003). Social identity and self-categorization theories provide a theoretical foundation for understanding work identity. Social identity theory states that identity, or identifying with others, produces a feeling of comfort or group acceptance for the members (Hogg & Terry, 2000; Tajfel, 1982; Tajfel & Turner, 1986). According to Ashforth, "Social identification is the perception of oneness with or belongingness to the social category or role," (2001, p. 25). Workers identify with their tasks, responsibilities, co-workers, and organization. Their sense of self is developed through the ongoing process of identification.

Self-categorization theory (Hogg, 1992; Turner, 1987) explains the mechanism of group *prototype*; an ideal candidate made up of a composite of personal and professional characteristics that typifies a member of the target group (Hogg & Terry, 2000). Self-categorization theory asserts that individuals determine their membership in groups based on a mental assessment of similarities and differences with regard to salient features of group composition. In other words, they perceive themselves as more alike than different based on a few key characteristics. These judgments are socially constructed and influence personal behavior. For instance, workers will modify their actions and appearance to better fit into the target population. The familiar "Dress for Success" concept encourages job candidates to conform to the desired group (Molloy, 1988).

When various factors become internalized into a fairly stable concept of self, a work identity has been created. Wallace (2002) defines work identity as "a person's sense of who she or he is, constituted through his or her positioning within the particular relations of power in the workplace" (Du Gay, 1996 in Wallace, 2002, p. 202). She also discusses the influence of managers in creating work identities, deliberately manipulating and influencing employees to adopt particular values and characteristics in the best interests of the organization (Wallace, 2002). Additionally, work identities will change as circumstances change (Sveningsson & Alvesson, 2003; Wallace, 2002, 2003). Wallace (2003) and Sveningsson and Alvesson (2003) discuss the role of management and organizational discourse as contributing elements in the development of work identities. They posit that workers are given or assigned work identities that will either be internalized or resisted by employees. "Internalization refers to the acceptance of influence because it is congruent with a worker's value system and/or because it is intrinsically rewarding," (Steers & Porter, 1991, p. 214). Therefore, if the work identity fits the employees' values and desires, there will be little resistance. Otherwise, the employees will experience decreased job satisfaction, possibly leading to a change in employment.

"Identification, in the generic sense, consists of placing things in terms of systematically related categories," (McCall & Simmons, 1978, p. 62). As researchers, we often classify individuals by gender, religious affiliation, nationality, educational background, etc. Some classifications are changeable and subject to choice, while others are predetermined and fundamentally unchanging. Building on these definitions, it follows that the work identity of IT professionals consists of the categorization of job experiences based on systematically related factors or characteristics intrinsically tied to the work environment (Steers & Porter, 1991).

IT Professional Work Identity is a socially constructed representation of an individual's self-perception of his/her own interactions within the employment environment. (Buche, 2003, p. 11; Darais, Nelson, Rice, & Buche, 2004)

EFFECT OF GENDER ON WORK IDENTITY

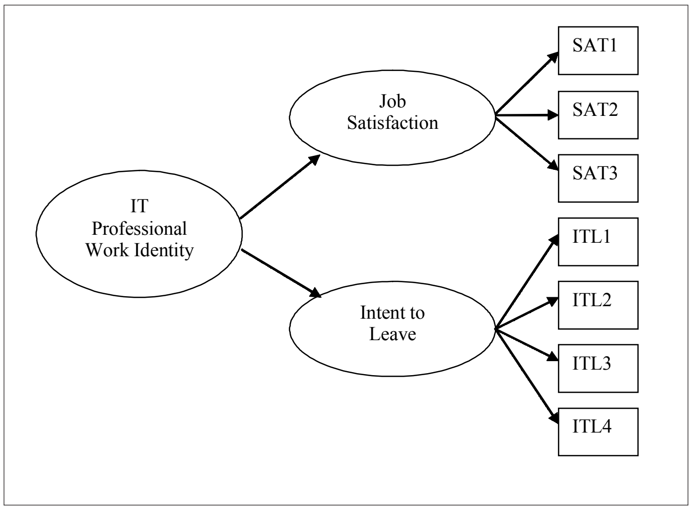
Do women in technology-related occupations consider themselves IT professionals? Or, are they more comfortable being classified as *female* IT professionals? Some research suggests that women in male-dominated fields are reluctant to be classified as *female* engineers (Jorgenson, 2002). Specifically, they object to the homogenous characterization of gender-specific exemplars of a work group identity (Jorgenson, 2002). Gender is not only a physical characteristic, it is also a socially constructed factor instilled through education and exposure. Research suggests that girls and boys are socialized differently through media inputs, education structures, and expectations from influential role models (Bartol, Martin, & Kromkowski, 2003; Gentry, Commuri, & Jun, 2003; Putrevu, 2001). Academic institutions and parents affect female participation in engineering and scientific professions by creating barriers to entry and by lowering expectations of performance in the mathematics and sciences (Wraige, 2004). These negative inputs may become self-fulfilling prophecies, eventually becoming internalized into the females' work identities. Organizations have a great deal of influence in socializing workers (Orser, 1994; Schein, 1988). According to Orser (1994, p. 12), "socialization is concerned with the transmission of beliefs and values from one generation to the next." In businesses, this includes task procedures, organizational policies, and behavioral norms. Each aspect eventually becomes internalized as part of the employee's work identity.

The comparatively few women who pursue engineering and technical careers in spite of these influences are faced with pressures to fit into the male-dominated work culture (Jorgenson, 2002; Melymuka, 2000; Trauth, 2002). Their work identities reflect the same level of professionalism and adherence to the practices and standards of the field. However, they also incorporate features unique to female professionals, such as work-family conflict, motherhood issues, female acceptance in the workplace, and paucity of female role models and mentors (Cukier, Shortt, & Devine, 2002). In addition to differences in the creation of work identities, it is possible that outcomes of work identity on job satisfaction and intention to leave an organization might be different for female employees. Results from a recent empirical study based on 240 survey responses suggest that work identity for female IT professionals is more strongly related to job satisfaction than for their male counterparts (Buche, 2005). Partial Least Squares (PLS Graph version 3.0) was used to analyze the data (Chin & Frye, 2001). Figure 1 shows the model presenting the latent variables and the associations between constructs (Buche, 2003, 2005). Essentially, the analysis indicates that women are less contented at work than males if their individual work identities are not a good fit with the organization. In general, women may choose to stay in their jobs and be miserable, rather than quit. The results of the empirical study reveal a meaningful difference in the influence of work identity on organizational outcomes based on gender (Buche, 2005). This study suggests that managers need to actively monitor job satisfaction and instill a fulfilling and agreeable work identity if they wish to retain productive, experienced female IT professionals (Wallace, 2002).

FUTURE TRENDS

Assuming that organizations make no changes, allowing work-family conflict to continue its assault on female professionals and ignoring the pressures of conflicting expectations, job satisfaction of female IT professionals will likely continue to erode. Worst-case scenario, a subset of employees experiencing lower job satisfaction might choose to exit the IT career field entirely. The current discourse on skills shortage among practitioners highlights the importance of actively changing these dynamics (Cukier et al., 2002; Trauth, 2002; Verton, 2004).

Figure 1. Model of IT professional work identity and outcomes



Note: SAT—Job Satisfaction, ITL—Intent to Leave

Females are a marginalized sector of the IT workforce (Jorgenson, 2002) and require managerial intervention to create a sense of cohesion within the organization. Avoiding discussion on these critical issues does not eliminate their negative impact. Rather, the opposite may occur; ignoring the debate lends support to sustaining an unhealthy and unsatisfying work environment for certain participants. With universities experiencing reduced numbers of students pursuing degrees in technology disciplines (Camp, 1997), corporations need to monitor the satisfaction levels of their workforce. Replacement workers with the desired skill sets will become harder to locate in coming years.

CONCLUSION

Female IT professionals are dedicated and enthusiastic contributors within their organizations. Similar to their male counterparts, their work identities include elements of job characteristics (i.e., skills variety and task significance) and role identity (i.e., technical or general business roles). But, being female in a male-dominated work environment influences their work identities in unique ways (Jorgenson, 2002; Melymuka, 2000). As the results of the research study indicate, work identity for females is more strongly related to job satisfaction than for male IT professionals (Buche, 2005). However, it is not yet known to what extent managers are able to influence work identity development. Future research should investigate this interaction and also the influence of work identity on various organizational outcomes. Also, future studies should include other factors that may have an effect on the outcome variables. For example, possession of highly valued and desirable job skills may also impact intent to leave. The study cited did not control for or include additional variables.

Previous studies have focused on the development of a somewhat static self-image, but current research is looking at work identity as a dynamic process, influenced by organizational changes (Alvesson, 2001; Sveningsson & Alvesson, 2003: Wallace, 2002, 2003). Taking the process model further, understanding work identity as both an emergent construct and as the antecedent of organizational outcomes will enhance management practices. The dynamic nature of the IT field and the pace of change create a situation of uncertainty and anxiety, with workers constantly revising their work identities. Female IT professionals need to be encouraged to remain in the field so that their expertise is not lost. Ideally, a longitudinal study is needed to assess the changes in work identity of this marginalized group over time. Management interventions should be implemented that deliberately promote organizationally sanctioned work identities that also meet the personal requirements of female IT professionals, followed by supervision and impact analysis. Realizing that changes in job-related tasks, resources and equipment, altered reporting structures, modified work practices (i.e., telecommuting), and a transformed client base (both internal and external to the organization) affect employees' work identities in the IT field. A strong alliance between personal and organizational needs can lead to improvement in job satisfaction and reduction in turnover intent.

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KEY TERMS

Identity: Reported self-perception of image constructed from various factors.

IT Professional: Someone working in the IT field in any of a number of job positions including programmers, systems analysts, network administrators, help desk technicians, project managers, computer scientists, etc.

IT Professional Work Identity: "A socially constructed representation of an individual's self-perception of his/her own interactions within the employment environment" (Buche, 2003, p. 11; Darais, Nelson, Rice, & Buche, 2004).

Job Characteristics: A model of various key factors that influence a worker's satisfaction and motivation in the workplace (Hackman & Oldham, 1976).

Partial Least Squares: A second-generation multivariate statistical approach to analyze relationships between constructs in a model that contains both observed manifest variables and unobservable latent variables (Chin, 1998).

Role Identity: Organizational expectations of responsibilities and activities.

Second Order Construct: A latent variable created by combining two other latent variables (Chin, 1998).

Self-Categorization Theory: A theory that describes how individuals determine their membership in groups based on a mental assessment of similarities and differences with regard to salient features of group composition (Hogg, 1992; Hogg & Terry, 2000; Turner, 1987).

Skills Variety: The inclusion of many and varied skills to accomplish one's work (Hackman & Oldham, 1976).

Social Identity Theory: A theory that states that identity, or identifying with others, produces a feeling of comfort or group acceptance for the members (Hogg & Terry, 2000; Tajfel, 1982; Tajfel & Turner, 1986).

Socialization: A process that "is concerned with the transmission of beliefs and values from one generation to the next" (Orser, 1994, p. 12).

Task Significance: The perception of value or influence produced by accomplishing one's work (Hackman & Oldham, 1976).

Gender and National IT Policy in Nigeria

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INTRODUCTION

Information technology (IT) has become a potent force in transforming social, economic and political life globally (Hafkin & Taggart, 2001). Without its incorporation into the information age, there is little chance for countries or regions to develop. More and more concern is being shown about the impact of those left on the other side of the digital divide—the division between the information "haves" and "have nots." Most women within developing countries are in the deepest part of the divide, further removed from the information age than the men whose poverty they share. If access to and use of these technologies is directly linked to social and economic development, then it is imperative to ensure that women in developing countries understand the significance of these technologies and use them. If not, they will become further marginalized from the mainstream of their countries and of the world. It is essential that gender issues be considered early in the process of the introduction of IT in developing countries so that gender concerns can be incorporated from the beginning and not as a corrective afterwards (Hafkin & Taggart, 2001). This article first gives a background to the Nigerian IT policy, followed by a gender analysis of the policy. It points out the gender issues to be incorporated in the policy and the strategies of ensuring women's ability to take advantage of IT. It finally makes recommendations on the way forward for incorporating gender issues in the Nigerian IT policy document.

BACKGROUND

The Nigerian government, in February 2001, formulated a national policy for IT to respond to the emerging global reality. The Federal Executive Council approved the national IT policy in March 2001, and implementation started in April with the establishment of the National Information Technology Development Agency (NITDA), charged with the implementation responsibility. The policy recognized the private sector as the driving engine of the IT sector. NITDA is to enter into strategic alliance, collaboration and joint venture with the private sector for the actualization of the IT vision, which is to make Nigeria an IT-capable country, using IT as an engine for sustainable development and global competitiveness. It is also to be used for education, job creation, wealth creation, poverty eradication and global competitiveness. Analysis of the IT policy document showed that it was comprehensive in scope. It recognizes the private sector as the driving engine of the IT industry (National Policy for Information Technology, 2003).

A sectoral application of IT has been recognized in the formulation of the IT policy, which involves the development of the following areas of the economy:

- Human resource development
- Infrastructure
- Governance
- Research and development
- Health
- Agriculture
- Urban and rural development
- Trade and commerce
- Arts, culture and tourism
- National security and law enforcement
- Fiscal measures and so forth

The National Information Technology Policy (NITP) addressed the various objectives pertaining to these aspects of the economy and the strategies that are to be adopted in applying IT for making these sectors economically sustainable. NITDA's strategies revolve mainly around three major approaches, namely: human resource capacity building, infrastructure capacity building and institutional capacity building.

GENDER ANALYSIS OF NIGERIA'S IT POLICY

According to Zunguze (2003), gender-based analysis is a process that assesses the difference in the impact of proposed and/or existing policies, programs and legislation on women and men. It compares how policy issues affect women and men and analyzes how and why this is so. Gender-based analysis challenges the assumption that policies, programs and legislation affect everyone in the same way, regardless of gender. This is often referred to as "gender-neutral policy." Gender analysis focuses on understanding and documenting the differences in gender roles, activities, needs and opportunities in a given context. It should result in policies, programs and legislation inclusive of women by taking into consideration the existing social imbalances. Gender-based analysis leads to informed policy making and good governance (Zunguze, 2003). Gender role analysis is useful to understanding to what ends men and women utilize Information and Communication Techologies (ICT; i.e., reproductive tasks associated with educating children, productive tasks associated with work, community tasks associated with volunteerism), whether use of ICTs is time-saving, and whether men's and women's time use is different (i.e., does one sex have greater leisure or does increased time flexibility create the potential for more "double shift" as telecommuting blurs distinctions between private (home) and public (work) domains). In Nigeria, the progress towards gender equality is very slow (Olatokun, 2003). This is noticeable in government appointments, students' enrollment in schools, political statements, government commitment to issues that are gender sensitive and so forth. Countless examples exist of political statements that have fallen short because they were not backed by policies. Below we present a gender analysis of the Nigerian IT policy document.

Gender Bias of the Nigerian IT Policy

From the content analysis of the Nigerian IT policy document, the word "women" was mentioned only in three places, namely:

a. Under the General Objectives section on page (iv), the (xiv) objective reads:

   To empower children, women and the disabled by providing special programs for the acquisition of IT skills.

b. So also in Chapter 15, titled, "IT popularization and awareness." In sub-section 15.2, objective (vi) reads:

   To draw on the intrinsic ability of women to propagate positive values within the society at large as an instrument for IT diffusion and promotion.

c. In sub-section 15.3 of the same chapter, objective (v) reads:

   Collaborating with the Ministry of Women Affairs to organize workshops and training in IT skills for women and other special groups.

The above shows that the IT policy relegated gender issues to the background. All through the policy document, gender concerns are not addressed in a way that shows an understanding of power imbalances and gender relations. It makes no attempt to show an understanding or appreciation of gender issues as evidenced in the use of gender-neutral terms throughout the document that seems to assume that by using these terms, it is including everyone, within broader categories of people without recognizing the different contexts, needs or contributions by different sexes.

Also, the policy's vision statement reads:

To make Nigeria an IT-capable country in Africa and a key player in the Information Society by the year 2005, using IT as the engine for sustainable development and global competitiveness.

And the mission statement reads:

To 'USE IT' for: (i) Education (ii) Creation of Wealth (iii) Poverty Eradication (iv) Job Creation and (v) Global Competitiveness.

From the vision and mission statements, the Nigerian IT policy does not have anything relating to gender. Though the vision and mission statements are based on the need to create knowledge in the various sectors of the economy, however, the statements could have been made more gender sensitive by recognizing that a disproportionate majority of the world's poor are women. Not only do too many women lack access to economic and social resources, but they also are too often denied basic human rights.

Though the policy recognized 15 sectors in the Nigerian economy, and addresses the various ministries, it fails to address gender and, in particular, women's concerns in context. In all of the 15 sectors addressed, the word "women" was only mentioned in one; that is, "*IT popularization and awareness,*" where collaboration with the Ministry of Women Affairs in the organization of workshops and training in IT skills for women was mentioned as one of the strategies. In the area of human resource development, which the policy recognized as a critical sector, one would expect that the policy would be very clear on issues of equal opportunity employment and on ensuring that women are accorded the chance of promotion to meaningful decision-making positions. There is provision for IT education at all levels, but there was no mention of how gender issues in the area will be tackled. Also, though the policy explains the government's desire to enhance the physical and faculty capacities of the existing educational institutions to achieve an increase in the numbers of IT professionals, the gender balance of these professionals is not given. It is a known fact that the IT industry is highly sex segregated, and women are found in disproportionately high numbers in the lowest-paid and least-secure jobs (Zunguze, 2003). Research also shows that in training sessions where there is a mixture of men and women, men tend to crowd out women's access to the training required for higher work (Zunguze, 2003). In the strategies spelled out under the human resources development sector, there was no explicit and clear-cut strategy as to how gender issues and concerns would be tackled.

In the sector of arts, culture and tourism, gender issues were also ignored. In Nigeria, cultural laws continue to perpetuate women's lack of access to productive resources by preventing women in rural areas from access to IT resources. Traditional and cultural views remain prevalent and women in Nigeria, as in the rest of Africa, live within patriarchal societies, confined to private spaces. The Nigerian IT Policy could have played a decisive role in addressing the imbalances by regulating women's access to the media, ownership and program content. Few women have been elevated to decision-making positions but more still needs to be done to close the gender gaps. Women's continued limited access to media and information systems are due mainly to their low status in society, traditional and cultural inhibitions, heavy workload compared with men, low purchasing power despite the fact that they work heavily, high illiteracy, absence in positions of formal authority or decision-making and so forth (Zunguze, 2003). The Nigerian IT policy does not recognize these important issues.

In the agricultural sector, the policy recognizes that Nigeria can use IT to reengineer agriculture for the purpose of maximizing food production, improving food self-sufficiency and security, increasing output for industrial raw materials utilization, providing employment and so forth. Thus, employing IT in the reengineering of the agricultural sector includes: food security; introduction of technologies like biotechnology and genetic engineering; aid in environmental monitoring and natural resource assessment; and agro-vision, which involves the use of metrological information with agro-based statistical data to predict the best conditions for exploiting Nigeria's rich agricultural potential. In Nigeria, where the greater percentage of farmers in the rural communities is women, the gender concerns along this line are not addressed. The needs of such women are not mentioned. Finally, in the composition of the Board of NITDA, there was no conscious effort to include gender balance.

Gender Issues to Incorporate into Nigerian IT Policy

Although IT policy and strategy varies considerably from country to country, most policies and policy instruments deal with similar issues. We present some gender issues that should be incorporated in the Nigerian IT policy, as follows. They include, according to Hafkin and Taggart (2001), but are not limited to, the following:

1. **Access and Know-How:** Women's access to ICT is dependent on many factors, such as gender discrimination in jobs and education

systems, social class, illiteracy and geographic location (north/south or urban/rural). As information dynamics accelerate their migration towards the Internet, people without access are bound to suffer greater exclusion. Women need to know how to use the technologies to their advantage. Information relevant to rural women must be disseminated in local languages. More traditional ICTs, such as community radio, audio-visual media and other popular media, should continue to be used, as these are more accessible.

2. **Education, Training and Skills Development:** Illiteracy rates for women in developing countries are far higher than for men. Training methods on ICT usage are often ad hoc and not appropriate to women's needs. These should be made gender sensitive by making them women-specific, ensuring ongoing user support and mentoring in the communities where the women live. Software design must respond to women's needs; for example, using multimedia and interactive CD-ROMs with graphic interfaces for illiterate women and automatic translation software would be more appropriate.
3. **Industry and Labor:** The ICT industry is highly sex segregated. Women are found in disproportionately high numbers in the lowest-paid and least-secure jobs. Research also shows that in training sessions where there is a mixture of men and women, men tend to crowd out women's access to the training required for higher work. Also, research shows that women and girls in IT and engineering tend to be more interested in the social applications of technologies (Keller, 1992; Rathgeber, 1995).
4. **Content and Language:** The dominance of the English language content on the Internet is a major concern raised by women's organizations in the south. Women's viewpoints are not adequately represented, while gender stereotypes (sexism and portrayal of women in media) predominate the World Wide Web (Zunguze, 2003).
5. **Power and Decision-Making:** Women are underrepresented in all ICT decision-making structures, including policy and regulatory institutions, public and private companies. This is because ICT decision-making is regarded as a technical area (typically for male experts), where civil society viewpoints are given little or no space rather than a political domain.
6. **Privacy and Security:** Privacy, security and Internet rights are other important thematic areas for women. This includes having secure online spaces where women feel safe from harassment, freedom of expression, privacy of communication and protection from "electronic snooping." These also include the passage of regulations that can threaten human rights.
7. **Other Issues:** These are listed as follows.
   - Network architecture and deployment (choice of technology)
   - Pricing and tariff issues
   - Licensing issues (ownership and control) (Jorge, 2001)
   - Strengthening technology innovation (research and development)
   - Human resource development for system support
   - IT labor force participation
   - Data infrastructure
   - Facilitating access to IT networks, including universal service obligations.

FUTURE TRENDS

According to Hafkin and Taggart (2001), IT can offer significant opportunities for virtually all girls and women in developing countries, including poor women living in rural areas. However, their ability to take advantage of these opportunities is contingent upon conducive policies, an enabling environment in their countries to extend communications infrastructure to where women live, and increased educational levels. As an indication of the future trends of gender and IT in Nigeria, we recommend in the next section some strategies that could be adopted for ensuring women's ability to take advantage of IT opportunities.

Policy

In Nigeria, as we have demonstrated above, there is already a national IT policy, but without provisions for gender issues. There is, therefore, a need for a deliberate effort to ensure the inclusion of gender concerns in Nigeria's national IT policy. This may take the form of sensitizing gender and development policy makers to IT issues. IT and gender policy makers need to enter a dialog so that IT programs meet the needs of women (Hafkin & Taggart, 2001).

Female Participation in Policy-Making

Greater representation of women in government and other policy-making areas will lead to increased attention to gender issues. Recent *info*Dev research (Chamberlain, 2002; Chamberlain, Hafkin & Huyer, 2002) found that women may not necessarily be gender sensitive. However, in areas where women are discriminated against, such as business, the experience of women will be invaluable for the identification of key action areas. Women may also be better equipped to identify key approaches to skills development.

Infrastructure

Increasing women's access to IT in Nigeria involves increasing availability of communication in areas where women live, since most women in developing countries live in presently underserved areas. Nigerian rural population is between 75%-82% and purely agrarian. Most women live in the rural areas. Thus, extension of infrastructure, particularly wireless and satellite communications, to rural areas and peri-urban areas is crucial to increasing women's access to IT. Emphasis needs to be on common use facilities, such as telecenters, phone shops and other forms of public access in places convenient and accessible to women (Hafkin & Taggart, 2001).

Education

Women represent more than half of Nigeria's population, yet they are denied educational and career opportunities, which are necessary for IT exploitation. If Nigeria wants to compete on a global level, she must nurture and utilize the talents of all women. The single most important factor in improving the ability of girls and women in Nigeria is to take full advantage of the opportunities offered by IT in education at all levels, from literacy through scientific and technological education, which requires interventions at all levels of education.

CONCLUSION

The digital divide is presently at the center of international development concerns (Hafkin & Taggart, 2001). Although most women in Nigeria have had little contact yet with IT, it is clear that there are many opportunities to improve the lives of women and their families. The options offered by IT have to be seized deliberately, because the cost of not doing so is very high. Women in Nigeria need to be given the chance to benefit from the opportunities that IT offer so as to enter the information age. IT is not a panacea for women's problems in Nigeria, since it can bring threats and challenges along with opportunities. However, IT offers many new possibilities that can offer Nigerian women a lifeline for economic, social and political empowerment. Thus, action and complementary activities are pertinent to exploit the options, but it will be worth the effort. Hence, we recommend that there is an urgent need for gender sensitization training of policy makers and state actors to make them aware of specific issues related to IT impact on women and that gender should be mainstreamed in all priority sectors addressed in the IT policy. Finally, there should be provision for a "gender and IT" sector in the policy, with concrete strategies about how to bridge the digital divide between men and women. It is hoped that the digital divide will no doubt be bridged provided these recommendations are followed.

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KEY TERMS

Digital Divide: Disparities/differences based on economic status, gender, race, physical abilities and geographic location between those who have or do not have access to information, the Internet and other information technologies and services, and the skills, knowledge and abilities to use information, the Internet and other technologies (ALA, 2000).

Gender: The fact or condition of being a male or a female human being, especially with regard to how this affects or determines a person's self-image, social status, goals and so forth.

Gender Analysis: Gender analysis focuses on understanding the differences in gender roles, activities, needs and opportunities in a given context.

Gender Gap: The apparent disparity between men and women in values, attitudes, voting patterns and so forth.

Information Technology: Encompasses all forms of technology used in processing and disseminating information.

Information Technology Policy: Policy guidelines that concern all forms of technology used in processing and disseminating information.

Policy: A course of action developed for the achievement of a set of goals.

Women: A woman is a female human being as contrasted to a man, an adult male. The term woman is used to indicate biological sex distinctions, cultural gender role distinctions or both.

Gender and Professionalisation in IT Fields

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GENDER AND THE EVOLUTION OF IT PROFESSIONS

From a historical point of view, IT professions have their origin in increasing computerisation, especially in the insurance and banking businesses. This stimulated a rise in demand for highly qualified programmers with the ability to take into account the economic side of business gains during the 60s[1]. To satisfy the need for such qualified people, computer science was institutionalised in universities in the 70s. The newly emerging software enterprises, mostly from the U.S., occupied the fields formally served by hardware enterprises and played a crucial role in the development of the IT industry. This included the development of new organisational cultures that were less hierarchically oriented. Moreover, the expansion of the sector and creation of new jobs enlarged the jurisdictional fields of work for software developers. At this stage in the evolution of IT professionalisation, we can find many optimistic views stating that new computing areas would be gender-neutral spaces that provided opportunities for women's participation (Deakin, 1984). Nevertheless, as Griffiths (1988, p. 145) pointed out at the end of the eighties, within a decade computers had been appropriated by men.

With the Internet boom of the 1990s, the sector became even more diversified in its jurisdictional fields, which hindered an institutionalisation of career paths and professionalisation[2]. New occupations arose alongside the technological progress in the information and communication industries. This brought about structural changes that influenced the development of professional groups: First, there was a common dynamic of innovation processes in the IT branch." This was followed by increasing standardisation processes in the working fields and an essential erosion of jurisdictional constancy within the professional groups (Baukrowitz & Boes, 2000). Moreover, the jurisdictional fields for computer scientists, especially the field of application development, were not yet totally monopolised by any particular group because there was "no undisputed dominance of information technological knowledge" (Hartmann, 1995, p. 164). Thus to a large extent, the failure to restrict the jurisdictional fields of computer science is the reason for "the low professionalisation" of the sector (Rothenwald, 2001, p. 17).

From a gender perspective, the first question that arises here is how women participate in this particular development of the IT professions. From a historical perspective, Kritzer points out that the so-called semi-professions (those without a recognized and institutionalised corpus of expertise) have been the main area of women's paid work, while the professions have been male-dominated (Kritzer, 1999). Connected to this division of work, we can also observe a horizontal gender segregation of professions with implications for the inclusion/exclusion of men and women from certain professional areas irrespective of task attributes that correspond to stereotyping in male or female terms. In this sense, Witz (1990, p. 675) refers to "professionalisation projects." Nevertheless, these projects also change over time. Gatta and Ross (2002) point out that changing societal expectations of men's and women's roles, changing skill mixes, declining discrimination, and reduced male resistance to women's entry into work influences the increase of women's presence in traditionally male occupations and also alters employers' expectations.

As we can see from historical discussions of computer science[3], women have always been involved in computing and mathematics. Nevertheless, several authors have shown that women are concentrated in those IT occupation areas with the poorest employment conditions, whereas men are overrepresented in fields that are more valued, such as technical management, systems analysis, and programming (Ruiz Ben, 2003; Webster, 1996; Webster & Valenduc, 2003; Woodfield, 2000). The question arising here involves the extent to which the professionalisation process of IT occupations represents an opportunity for women to play an active role in the innovation paths of the information society, as well as the gendering or de-gendering practices linked to this process. Our aim in this chapter is to provide an overview of the scholarly literature in the social sciences on the debate about gender and professionalisation in IT fields and sort through the current discussion about the professionalisation of software development in Germany. We present evidence for the gender segregation in IT professions and discuss the key issues that have been addressed by the empirical literature.

BACKGROUND

According to Abbott (1988), professionalisation refers to the expertization of work and the struggles over jurisdictions of expert work. When such jurisdictions become vacant, professions develop and groups of expert workers can convert their work and knowledge into a currency. Particularly abstract knowledge systems are the main currency basis for inter-professional struggle according to Abbott. In IT fields, there is no well-established definition of IT professions, as international reports have stated (Deiss, 2002). As a consequence, the spectrum of existing studies reveals significant variations in the definitions of IT professions, according to the scope of each study and the motivations of its authors (Webster & Valenduc, 2003). Common for the whole IT industry are several factors related to the transformation of work practices: high personal implication; increasing involvement with customers; personal responsibility for continuous training; the need for continuous upgrading of employability; flexibility in work time and location; unpredictable work rhythms, and so forth (Webster & Valenduc, 2003). Moreover, innovation sources and the knowledge systems operating in this industry are highly diverse and increasingly demand soft-skills, which are linked to gender stereotypes. However, some research has shown the persistence of gender bias in the professionalisation process of IT occupations (Huws, 2003; Huber, Reiff, Ruiz Ben, & Schinzel, 2001; Ruiz Ben, 2002, 2003, 2005; Wacjman, 2002; Webster, 1996; Webster & Valenduc 2003).

The explanations for the causes of gender inequalities in the professionalisation process of computing fields cannot be reduced to a simple view of gender constructions. A set of factors lead to the persistence of the gender gap in IT professions, as Webster and Valenduc (2003) note: "time constraints, unequal sharing of housework and children and elderly care, constitution of the harmonisation of the family and professional life as mainly an individual and female problem, total availability model, male environment, low access to training, one way flexibility, under valuation of women's competences and skills." (p. 144) The culture of professional IT engineers is marked by a shared pleasure of both skills: hands-on competence in tinkering, and the abstract competence in logical, analytical problem solving in engineers and software developers' circles (Faulkner, 2000), which results in developing an exclusive, informal culture and professional habits. Software specialists (with men in the majority) build their identities in this cultural context, bridging their early socialisation practices with their professional practices. However, their socialisation differs from that of women, as does their professional motivation in software development (Faulkner, 2000).

This represents the main line of argumentation for explaining the gender gap in computing professions. It emphasizes the correspondence between the gender divide and the social/technical divide, or the division in computing between the physical and the social realms on the one side and the technical realms on the other (Faulkner, 2000; Woodfield, 2000). Nonetheless, from the perspective of the demand for labour, the growing presence of workers with hybrid qualifications indicates that qualification in computer science is not a general guarantee for entering the IT labour market. As Müller (2000) argues, "The association between qualification and career advancement legitimates the meritocratic ideology of organisations. This renders the gender difference as a structure of discrimination 'objectively' obsolete" (p. 20). Moreover, within organisations, several factors support this ideology, such as specialisation or the increasing development of informal structures[4].

On the other hand, according to the actual organisation restructuring Halford and Leonard (1998) argue that personal identities as well as the performance aspects of the employees are redefined. This means that traditional gender regimes in organisations are destabilised by the breakdown of rationalisation. One example of change in IT organisations is the increased value placed on diversity in industrial production. This transformation entails an intensified search for innovative strategies and is increasingly considered in many software firms. It has expanded in the sector because the integration of a spectrum of diverse perspectives augments the probability of accepting innovative products. Related to this, we can observe the heightened importance of aspects such as requirements analysis, usability, and teamwork in the software development. Thus, we can conclude that structural conditions regarding working practices and institutional support, as well as cultural factors influencing the definition of expertise within organisations and in everyday practices to a large extent determine the gendering processes of IT professional projects. Professionalisation theories can serve as a basis for analysing the combined effects of the factors mentioned above from a long-term perspective without leaving aside the importance of current practices within organisations particularly the mutually determined construction of technology and gender meanings. In the next section, we present this perspective in more depth.

PROFESSIONALISATION AND GENDER IN THE GERMAN IT SECTOR

Drawing on professionalisation theory from a gendered perspective, the main goal of our study is to analyse the strategies of monopolisation of software development as a profession, (i.e., its demarcation and enclosure in terms of qualification requirements and delimitation of related areas of expertise), in order to reconstruct the meaning of gender in this process. The two main research questions in our study are: (1) What are the main characteristics of the professionalisation process of software development in Germany? and (2) What are the opportunities for women to enter in this professionalisation process? To answer these questions we take into account the influences of academia, the practice of software development and professional associations, as well as of the state. We have considered the perspectives of IT-specialists working in the practice of software development and also of those actors who decide on the entry of new professionals into the practice of software development in the professional arena, (i.e., personnel managers in software enterprises). Considered as the main source of professional qualification for the practice, we have included the self-definitions of computer science from the perspective of the academic core. The empirical basis of the study is based on open interviews with professors of computer science (6), personal managers (14), and software developers (29) in software enterprises. Regarding the characteristics of the enterprises, we chose a balanced number of software companies in different sectors of software development and of varying size. The interviews were conducted between the end of 2000 and 2001.

Our results show that computer science as a discipline is widely recognized in the academic arena and also supported by a large professional work organisation[5], which is also linked to the IT industry. However, the discipline does not have an extended, recognized knowledge monopoly in the IT industry, neither a moderator nor an integrative role in the heterogeneous area of IT. In large enterprises, qualification demands are higher and more specialized, reflecting a more accurate division of work and a clearer delimitation between "technical/social" areas. Here we can observe some professionalisation patterns supporting a kind of jurisdictional stability in software development. Hence, there are concrete qualification demands, internal training, and institutional supports (professional associations, trade unions). Bolstering this development, application areas, located in most medium and small size companies in the German IT industry, undertake the risk to adapt software products to concrete customers' needs in the short-term. This also entails personal risks from the perspective of the work force with time constraints tied to projects, a non-stop availability model, one way flexibility, low access to training and no support for balancing family and professional life, which means workers assume responsibility for their own family and old-age care. How is gendering embedded in this particular professionalisation path of software development? On the one hand, we can observe different gender segregation models that correspond to the different working conditions in larger organisations and in medium- and small-size enterprises. On the other hand, definitions of tasks as technical *in* IT fields serve as a fluid demarcation line or, in the terms of Bourdieu and Wacquandt (1992), a source of distinction that genders working areas throughout the IT industry. This definitions are a crucial basis for building symbolic knowledge systems and with it, professional jurisdictions as described in Abbott (1988).

In large enterprises, in which working conditions are more favourable in terms of working time options or integrated programs for balancing family and professional life, women very often work in tasks coded as socially oriented, such as program or quality management even though they have a qualification background in mathematics or computer science. Technical areas remain a male domain. This horizontal segregation is supported through the adaptation of the mutually reinforcing gendered expectations of personnel managers and workers. In smaller enterprises, in which time pressure and working conditions are worse, young women without family responsibilities in particular find work chances in areas such as consulting or design. Areas defined as "technical"—although with a very diffuse and changing definition—remain also in enterprises of this size a masculine domain.

In sum, cultural habits linked to the construction of technical meanings and jurisdictions in IT organisations contribute to gender segregation and are reinforced by structural factors such as the lack of resources invested to support a balance between family and professional life. Nevertheless, some cultural changes exist within software development practices aimed at getting closer to customers' needs and also influenced through the internationalisation of the IT industry. As we explain in the next section, these changes may create increased opportunities for the participation of women in the professionalisation project.

FUTURE PROFESSIONALISATION TRENDS: CHANCES FOR WOMEN'S ENROLLMENT

The desire to understand and translate customers' needs into software products has increased the importance of social aspects in software development. Parallel to this, those areas that can rapidly standardise their production processes can easily move to other countries. This has spurred a cultural change in the IT industry, particularly in large enterprises, which are placing more and more value on diversity. Offshore practices in the IT industry bring changes in the definition of technical areas and tasks. Taking into account that technical tasks are easier to standardise and to offshore as those linked to requirements analysis, we could argue that the connotations of prestige in technical areas will also change. Windows of opportunity open for the participation of women in the professionalisation process of IT fields not only in western countries, but in developing countries[6] building regional stratified clusters or influence areas (i.e., India, Latin-America, South-Asia). Parallel to this we observe inclusion/exclusion forms of workers in/from IT fields interacting with contextual differentiation and categorisation patterns (gender, social stratification, race, age)[7]. Nevertheless the particular occupational segregation linked to gender and to the internationalisation process of IT fields remain a black box. Further research is needed to analyze the consolidation patterns of prestige areas in IT or, in other words, how decision fields in software development, those jurisdictions closer to power, become monopolized and gendered.

CONCLUSION

What characterizes professionalisation in IT fields in Germany? Demarcation of particular areas for high-qualified technical specialist correlates with other exclusionary factors, for example, qualification or lifelong training, which is essential for continued participation and promotion in the IT branch. Employees do not receive equal guarantees in investment in in-service training (Berndes, Kornwachs, and Lünstroth 2002) and particularly in small- and mid-size software companies, continuous training is an individual matter. Corresponding to new post-Fordist forms of work (adaptation to constantly changing demands, increasing self-responsibility, availability), the present creed of flexibility in the IT sector—mainly in smaller companies—turns out to mask differentiation processes which develop in relation to the employees' gender, age, qualification, and personal circumstances. What are the opportunities for women to participate in this process? Gendering (linked to other categorisation factors such as age, qualification, and familial situation) is embedded in the professionalisation project of software development. The compatibility of family and working life seems to become superfluous following the logic of the persisting model of the male breadwinner. Acker (2002, p. 317) concludes: *"*With the new economy, which grants some women access, a new hegemonic concept of masculinity is developed, just as there is a factual male dominance in the fields of information technologies, computers and financing*"*. From the perspective of the professionalisation of software development in some areas of the IT branch and considering the necessary integration of "social" and "technical" areas, women are theoretically in a very advantageous position. However, contradictory impulses are discernible when it comes to creating strategies for avoiding the femininisation of the profession: the emphasis on the priority of formal-technical skills (and time disposition, since they form part of the competent impression) and the naturalisation of social skills in order to protect men from such demands. Escape routes for the retention of a "male profession" are thus conceivable and realistic—developers (predominantly male) receive additional in-service training, which means that these skills are building a symbolic knowledge system parallel to the professionalisation of particular areas of software development especially in larger companies. This leaves the professionalisation process of software development open and fluid in many areas, as well as the technical connotations used as "distinction lines" for gendering. The open question regarding IT is how expertise related to the social skills coded as feminine in areas such as project and quality management—crucial in the future development of the IT industry—are being culturalized and achieve the status of "currency". And moreover, who are the people who monopolize and will continue to monopolize this "currency".

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KEY TERMS

IT Fields (Information and Technology Fields): Professional and occupational areas of work related to the production and selling of information technologies.

Occupation: Principal work by which one earns one's livelihood.

Offshore: Building of dedicated captive centers by a company in remote, lower-cost locations.

Profession: Knowledge based occupations achieved following standard periods of higher education and/or vocational training.

Professional Work Organisations: Administrations or companies with strong collegial control that claim for professionalism.

Professionalisation: Struggles over jurisdictions or demarcated areas of expert work that result in the expertisation and monopolization of work.

Professionalism: Occupational control and definition of work including educational standards.

ENDNOTES

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2. See the definition of professionalisation in the Key Terms section.
3. See www.frauen-informatik-geschichte.de from 2003-05-23
4. See also Ruiz Ben (2003)
5. Gesellschaft für Informatik (GI)
6. See Mitra, S. (2004). Retrieved March 25, 2005, from http://info.worldbank.org/etools/BSPAN/PresentationView.asp?PID=1175&EID=603
7. See http://www.bib.ulb.ac.be/cdrom/wer_lawitie/back/rub_toc.htm

Gender and Software Engineering

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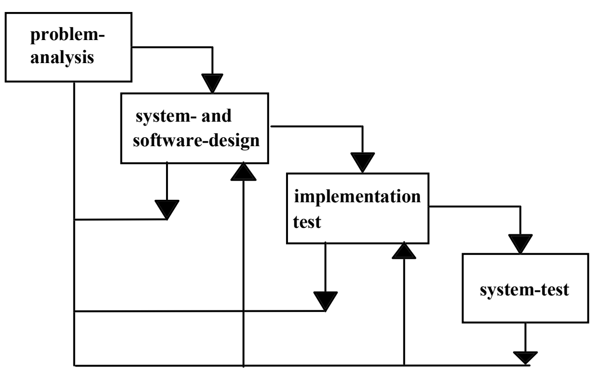
HISTORICAL BACKGROUND

The history of software engineering is not very long, but rather intensive. In the beginning of the 40s, programming was seen mainly as manual, electronic engineering job, done by women, in particular mathematicians (compare e.g., Schinzel and Zimmer, 1998). Changing more and more to an intellectual, mathematical, high status task programming started to be male-coded and remained to be done by men.

The first computer systems were developed for military purposes. The end products seemed to be not adequate to the expectations of the users. Most system engineers did not care about the users' needs, nor did they consider any kind of documenting their own thoughts and works as being necessary. This led to the so-called "software-crisis" in the sixties and raised the discussion of adequate–in terms of more structured and more transparent—methods in software engineering. One important result of this discourse was the classical "waterfall model" (see Figure 1).

Software development is seen as sequence of single phases. The output of the preceding phase delivers the input to the proceeding phase, returning to a former state is in principle possible, but there is also a point of no return caused by cost constraints. Generally, this approach considers system development as step-by-step procedure without iteration, only small punctual adaption should be done. User-involvement is often limited to the first phase, namely to the problem analysis. In order to define the functions of the computer systems the users have to serve as information source, describing the current working process, and formulating system requirements. The underlying engineering perspective clearly makes it to the designers' task to come up with a technological solution. The contact with users is limited to the first step when specifying the functionality of the system and the to the last step when the system is delivered.

Figure 1. The waterfall model

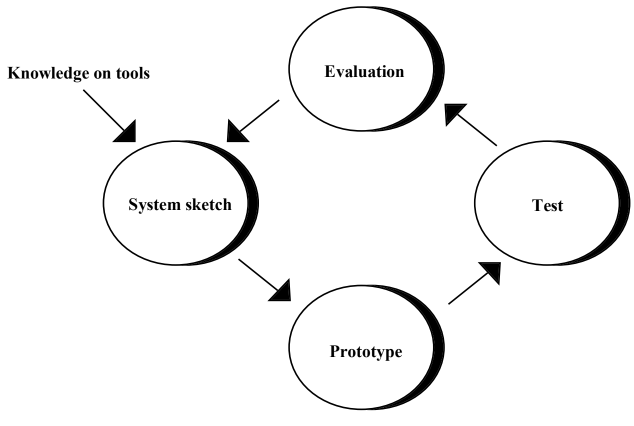


This treatment of system design and development still lead to inadequate products and as a consequence more attention to the users' needs was necessary. In particular, in the growing commercial and non-military application fields it became clear that there must be a stronger cooperation of engineers and people from the concerned organizations.

The new "socio-technical system approach" stresses the relation of human aspects and computer aspects trying to find an optimal "fit" for both (Mumford, 1971). Contrary to the purely "engineering" perspective, it has become accepted that social dynamics play a crucial role in the design and development procedure. Consequently new methods of system design integrating social aspects have been developed. In particular, the communication problem between users and engineers was identified as main source for badly specified systems. Thus, the involvement of the users during the whole system design—and development process became a necessity—this was the birth of (e.g., the idea of participatory design) (Floyd & Keil-Slawik, 1983) and of methods called "prototyping" (see Figure 2.

In the literature, there are some different models (e.g., incremental model, spiral model, etc.), which do have the same basic ideas of the prototyping approach: the iterative involvement of the future users of a system. A system sketch, a main kernel is implemented in cooperation with the users. After a

Figure 2. The prototyping approach



testing phase with users (which is supervised by system-experts or tutors), the evaluation of the first prototype will lead to a step-by-step extension of the system.

Besides communication features this approach requires a new understanding of system design: Computer scientists are not the experts from the application field. Consequently, they have to cooperate with people actually working in the according environments.

In the last decades, this approach of considering software engineering as organizational modeling was further developed. It became clear that system development is organizational development (compare e.g., Briefs, Ciborra, & Schneider, 1983; Kling, 1984). The design and introduction of a computer system imply changes in the organizational structure and organizational aspects strongly determine the design and specification of technological systems.

Summarized it can be stated that in the last decades the view on system development changed a lot. Users were more and more involved—ranging from pure observation at the beginning of structured system design to contemporary user-centered design methods (see also Kuala, 2003). In particular, the view that computer system design is organizational design implies many decision-making competencies of the users. Thus, it could be stated that there is a new understanding of constructing technological artifacts leaving the path of "objective" modeling following the view of "negotiated constructions." The development context in terms of who is involved, which competences do these people have, which budget and time constraints play a role and the like influences the shape and function of systems. Consequently the process of system design is embedded in social settings and therefore always very specific (see also Hanappi-Egger, 1998, 2000). The author demonstrated this with computer science students: All students got the same task of programming software systems. At the end of the semester, there were as many (different) solutions as development teams.

The next question immediately is if system design is the result of social processes, which role plays "gender?" In other words, if the participants of system design are "gendered," how does this influence the design and development of software systems?

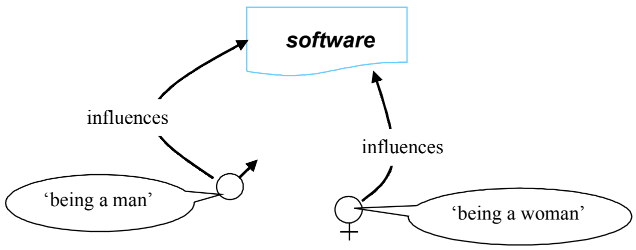
THE ROLE OF GENDER IN SOFTWARE ENGINEERING

From an organizational point of view, there are specific gender patterns and gender relations structuring organizations and consequently the social interactions. In other words, "sex" is associated with social constructions of gender roles and behavioral expectations. Biologically identified "women" are more likely expected to be feminine and men are expected to be masculine. This social mechanism tries to match the biological and the social gender of human beings. At the same time there is a gender hierarchy subordinating "female" coded activities and capabilities. West and Zimmerman (1998) call this "doing gender" referring to the fact that there are processes in organizations, taking place producing and reproducing gender relations (see also Hanappi-Egger, 2003).

Combining the two approaches, namely that gender plays a crucial role in social settings in general and that system development is a social activity (as presented in the historical overview) leads to the statement that gender has to play a role in the design and development of technological artifacts, too (for a general discussion see Hanappi-Egger, 2003).

In order to elaborate this statement, an analogy to the built environment can be drawn: From a design perspective in the built environment Kennedy (1981, p. 76) exemplifies gender-specifics in architectural practice: The female principles consists of more

Figure 3. Gendered design based on biological gender



user-oriented, more ergonomic, more functional, more flexible, more organically ordered, more holistic/complex, more social, more slowly growing. The male principles are designer oriented, large scale/monumental, formal, fixed, abstractly systemized, specialized/one-dimensional, profit-oriented, and quickly constructed. Wajcman (2001) doubts this approach since there are many intra-gender differences and several "male" characteristics are rather caused by commercial imperatives than by biological gender of the designers. Nevertheless, she establishes the connection between the built environment and patriarchy and shows that it is mainly the (shared) cultural assumptions on gender roles (such as gender-specific division of labor) which shape the design and development of objects[1].

A similar reflection will be made in the following for computer-systems:

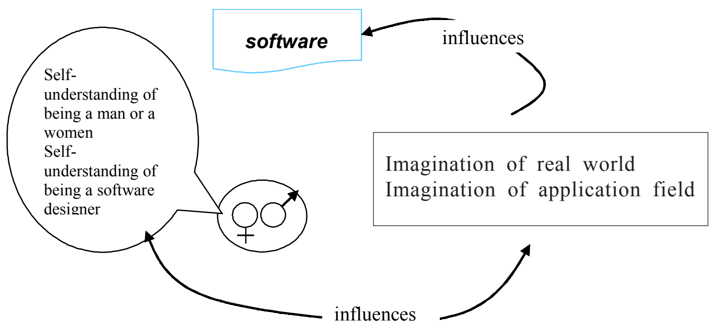
One main critique on the development of technological artifacts is the male dominance. Mainly men are designing and developing systems. Consequently, it is assumed that a very specific—namely male—perspective is implemented. The stronger involvement of female engineers should lead to more diversified perspectives and consequently to "better" solutions.

Evidently, this approach is based on a rather biological understanding of gender. Men as such and women as such do have different perspectives useful for the design of technologies. This essential view neglects the role of professional socialization: As several scholars (e.g., Rommes, Oost, & Oudshoorn, 1998) mention there is no empirical evidence that women design systems differently. Hanappi-Egger (2004a) stresses the importance of hegemonic ways of perceiving problems in computer science educations and thus leading to a rather homogenous self-understanding of both male and female computer scientists. In other words female engineers often do share more with male engineers as (e.g., with female social scientists). On the other side, it has to be noted that women often leave the technical field after some time due to their unwillingness to adapt to the heavily male coded professional culture. Thus, the "main stream" in engineering is "male stream." Attributes such as "fascinated from technology, anti-communicative, freaky, anti-social" and the like are gendered codes linked with people working in the technological field. In addition, as it is evident, these are male codes. The effort to increase the number of females in computer science can be positioned into the liberal feminist perspectives, since basically the organizational settings and systems are not questioned. Women have to adapt to the given circumstances and they have to be trained in being self-confident. Consequently, this view often is called the deficit-oriented approach identifying women's deficits as the crucial reason for the under-representation of women.

The importance of efforts bringing more women into the field of technology shall not be de-valuated. Nevertheless, one has to keep in mind that implicitly the "gender" issue is strongly connected with being a woman in a male-dominated field. Only little attention is paid to the fact that gender issues concern men, too, in terms of hegemonic gender patterns described in the already mentioned terms of being freaky and fascinated by technology or being a hacker.

As soon as this essential approach is questioned, one has to face that it is not so much the biological determinism of gender playing a crucial role in the design of systems, but it is the socially constructed way of perceiving gender and gendered processes. Studies of the development of information technologies, for example, indicate that design practices are dominated by the so-called "I-methodology" in which innovators consider their own preferences and skills to be representative of those of the future user (Akrich, 1995). The deconstruction of technological artifacts shows a gender-bias in the design of technologies: workflow management systems incorporate a specific view of division of labor in which "female" tasks are heavily forgotten or taken as irrelevant. The hidden social mechanism

Figure 4. Gender scripts-based design



leading to this phenomenon can be explained by the Figure 4.

As Akrich (1995) has suggested, "innovators are from the very start constantly interested in their future users. They construct many different representations of these users, and objectify these representations in technological choices" (Akrich, 1995, p. 168). As a result, technologies contain scripts: These scripts determine the way future users are seen, which rights, competences and skill are anticipated and consequently realized. Since these scripts reveal a gendered pattern, it can be assumed that gender scripts in terms of self-understanding to be a man or a woman but also the self-understanding of being a software designer and its gendered codifying are incorporated into the technological artifacts. This means that designers and developers as social entities have (often unconscious) gendered perspectives approaching the settings they are going to model in a software system. Consequently, they represent also their gendered imagination of the real world as well as of the application field and incorporate those in software systems.

Even though this perspective stresses the importance of gender scripts as part of social settings, it still sticks to a view that gender is an attribute, something people "are."

Recent gender studies focus less on the bodily difference, but more on the ways of ascribing gendered images to them. Consequently the focus of interest is on "doing gender." With respect to this gender, is a dynamic producing and reproducing gendered understandings in social interactions. It is an essential part in social settings and cannot be avoided, but the way of constructing gendered meaning can be reflected on. This leads to the necessity of questioning gender scripts and their incorporation in the design and development of artifacts. Hanappi-Egger (2004) calls this "triple loop learning." In other words, system development has to be put in the social setting and vice versa and requires a gender diversity-related approach: Gender diversity refers to multiple identification aspects and tries to overcome gender-dualism as well as exclusion mechanisms based on social categories such as gender, sexual orientation, age, ethnicity, and the like. Instead, contextual dynamics are seen as driving force in system design and development. In other words, a new approach to software engineering has to be developed which will be sketched in the following.

BREAKING CONVENTIONS: GENDER DIVERSITY IN SOFTWARE ENGINEERING – FROM SINGLE TO TRIPLE LOOP LEARNING

In order to make the hidden assumptions on the social setting of system designers visible, the reflection on assumptions made a-priori is important. Hanappi-Egger (2004) calls this "triple loop learning" based on the idea of Flood and Romm (1996). Flood et al. (1996) described triple-loop learning as a cyclic process consisting of three loops: The first loop (the How? loop) is built around the question "Are we doing things right?" The second loop (the What? loop) is built around the question "Are we doing the right things?" The third loop (the Why?

loop) is built around the question "Is rightness buttressed by mightiness and vice versa?"

Concerning software engineering processes, these three loops can be assigned to the following steps:

- **Single-Loop Learning:** Questioning the functionality (doing things right)
- **Double-Loop Learning:** Questioning the specification (doing the right things)
- **Triple-Loop Learning:** Questioning the mental models and scripts

Step one (single-loop learning) and step two (double-loop learning) are well-established activities in system development. Proofing functionality and the adequateness of the specification are no trivial tasks, but they are accepted as essential parts in the development processes. Much effort is put on the attempt to grant correctness in syntax as well as in semantic. Step three (the triple-loop) is not yet part of system development, but is necessary to prevent the implementation of very specific and exclusive perspectives on the underlying social framework.

In order to make these hidden assumptions visible, the third learning step is necessary to open up a space for discourse. From the perspective of the social shaping of technology we have to add this crucial learning loop in the design and development process: In terms of system engineering this means that besides developing the system, a meta-level has to be established allowing participants to reflect on mental models, on assumptions and in particular on their scripts influencing the way of specifying the system. So the questions to be discussed are: How does it come that we came up with this specific specification? Which assumptions concerning social relations in terms of division of work, power, and communication have we made? How has our self-understanding determined the system specification?

Clearly, this opens up a methodological problem. How can this third learning loop be induced? The deconstructive approach of the author which is currently part of a forthcoming research project is called "mind scripting": Based on the so-called memory work of Frigga Haug (2001), a German social scientist, system developers are asked to write texts related to a specific topic within their work setting (such as "quality" or "modeling").

The presumption of this method is that individuals appropriate social, organizational, and professional formative contexts and interpret, transform, select and reconstruct reality according to the mental models acquired within this process. These mental models are not only individually shaped but are also collectively shared constructions of reality. Consequently, deconstructing and comparing written texts, which can be read as contextual, selective, and temporal representations of the writer, can be used as source for making mental models and their gendered dimensions visible. "Mind scripting" in an innovative method, because:

- It really allows for deconstructing the hidden and unconscious imaginations by asking for a piece of memory such as "Last time when I had a team-meeting in the software development project"
- Since the texts are written in a third person, it is anonymous and allows for "objectified" analysis and discussion
- Deconstruction is done by putting questions such as "How does the author describe him/herself? Which other men or women appear in the text and how are they described? Where are ambiguities, contradictions, and jumps?" and also questions such as "Which causalities does the author construct? Which links are assumed"
- The comparison of the texts highlights similarities and differences, so shared views and perspectives can be identified

With respect to software engineering and gender, this means that mind scripting can be used to make the mental gendered maps of system developers visible. The according texts can be linked to their professional (gendered) self-understanding. The analyses of these texts within a development team may serve as source for discussing pre-assumptions, stereotypes, ways of thinking, but also to discuss which approaches are excluded and neglected.

Clearly, there is further research needed in order to elaborate the concept of gender-inclusive software engineering, in particular to come up with new methods of designing and developing technological systems.

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KEY TERMS

Gendered Patterns: Hegemonic behavior in terms of gendered codes such as masculinity and femininity.

Mind Scripting: Deconstructing textual pieces of memory.

Model: A reduced representation of real world settings.

Participative System Development: The design and development of systems involving the users' perspectives.

Prototyping: An iterative process to develop a first version of a system serving either as starting point or as specification for the end product.

Scripts: Mental references of social settings and expected behavior.

Software Engineering: The discipline devoted to the design and development of a software system.

System Specification: Determination of requirements and functions of a system.

Technological Artifact: Technological objects understood as result of construction.

Triple-Loop Learning: Model of learning with at least three feedback loops concerning questions such as "doing the right things," "doing things right" and "how does it come that we decided to do these specific things."

ENDNOTE

[1] As an example, the design of houses and their rooms can be taken: Usually men and kids have private rooms (such as own bedrooms or working room), while women often have only rooms to be shared with others.

Gender and Telework in Information Technology[1]

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INTRODUCTION AND BACKGROUND

Information technology (IT) work is often distributed geographically through practices such as teleworking. Telework lends itself well to IT workers because they work easily with information technology, which is required for telework, and because many IT jobs consist of knowledge work—the creation and analysis of symbols and ideas—which may be done anywhere and anytime.

Advances in information technology make distributed work possible. Globalization and the need for organization flexibility make distributed work necessary (Davis, 1995). Organizations distribute work to take advantage of scarce and inexpensive talent, enhance innovation and product design, and to reduce real estate costs, development time, and labor costs. Workers choose distributed work to balance work and life demands, reduce commuting time, accommodate disabilities, and take advantage of distant opportunities. Telework, a form of distributed work first described by Nilles (1975), has established itself throughout the United States. We discuss telework trends and provide some data describing teleworkers in IT professions in the United States.

Four forms of telework are commonly used (see Key Terms; Bailey & Kurland, 2002; Kurland & Bailey, 1999). Most teleworkers use a combination of these forms, although home-based telework is most prevalent (Davis & Polonko, 2001). Each form of telework is practiced for different reasons and produces different work experiences and outcomes (Bailey & Kurland, 2002; Davis & Polonko, 2003; Helling, 2000).

A national survey of telework practices in the United States was conducted in 2001 under sponsorship of the International Telework Association and Council (ITAC) and AT&T (Davis & Polonko, 2001). The sample was stratified to represent all U.S. households and was diverse with respect to gender, ethnicity, occupation, organization size, and industry. Results showed that there are approximately twenty-eight million teleworkers in the U.S. Compared to nonteleworkers, teleworkers are significantly more likely to be from the Northeast and West, male (54% of teleworkers), have higher education and income, work in professional/managerial occupations, work in industries such as construction, professional/scientific/technical services, health care/social assistance, and work in very small and very large organizations. There were no significant differences in telework practice for marital status, race/ethnicity, and age.

Davis and Polonko (2001) report several findings concerning telework and its impact on ability to balance work and family demands that are relevant to IT professionals. Teleworkers, especially those who work at home, are more likely than nonteleworkers to report working longer hours and that the demands of their personal life take time away from their work. They also report more difficulty relaxing at home when doing non-work related activities. However, teleworkers are also more likely to state that their family members and friends report less unhappiness with the amount of time they spend working at home, report that their home life is less likely to prevent them from working the amount of time they want to work at home, and that working at home interferes less with other activities in their personal life. These differences suggest that teleworkers may be better able to manage the time they spend working at home compared to nonteleworkers. While teleworkers may experience some personal costs, such as difficulty relaxing, they experience significant benefits compared to nonteleworkers in terms of less interference between work and family roles. Women may particularly benefit from telework because they are often responsible for childcare.

Research examining women teleworkers shows mixed benefits. Women teleworkers may experience less stress because they have more control over their time, do less commuting, experience fewer distractions, and are available to their families during the day (Kraut, 1988; Olson & Primps, 1984). On the other hand, women teleworkers may also experience greater stress due to reduced separation between work and family obligations resulting from bringing the workplace into the home (Olson & Primps, 1984). All teleworkers report working more hours (Davis & Polonko, 2001; Mirchandani, 1998).

Men and women adapt differently to work at home. For example, the time saved by reduced commuting gets used differently; women tend to use this time to do household chores, whereas men use this time to do more job-related work (Steward, 2000). Both men and women maintain a separation between work and family, but they do so for different reasons. Mirchandani (1999) reports that most women state that they separate work and family to reduce the stress of simultaneously attending to work and family obligations, whereas no men report such reasoning. She adds, "For women, the home is not a place of nonwork, but rather another workplace" (p. 92). Women teleworkers, especially those with children, may experience more difficulty in balancing work and family life than men (and women without children). Yet women claim to choose to telework as a means for balancing work and family obligations (Beasley, Lomo-David, & Seubert, 2001).

TELEWORK IN IT ORGANIZATIONS

Telework may be easier for IT workers due to the knowledge content of their work and their facility with using technology, although research results are mixed. A study of IBM teleworkers and nonteleworkers showed no difference in work family balance (Hill, Hawkins, & Miller, 1996; Hill, Miller, Weiner, & Colihan, 1999). In participant interviews, many claimed that teleworking helped them fulfill family obligations and strengthen family relationships, whereas others felt that teleworking blurred the boundary between work and family life and therefore made it more difficult to balance work and family demands.

Telework affects different aspects of work-family conflict. Selgrade and Davis (2005) studied a sample of teleworkers that included IT workers as well as workers from other professions from eleven organizations throughout the United States. They found that the effects of work interfering with family (WIF) were different than the effects of family interfering with work (FIW). Results showed that WIF, but not FIW, was negatively related to telework satisfaction and organization commitment and positively related to turnover intentions. Moreover, WIF increased with telework duration, whereas FIW increased with the number of children (Selgrade, 2004).

We report the following findings from a study of IT workers in eleven organizations. Major, Davis, Sanchez-Hucles, Germano, and Mann (2006) describe the research in more detail. We report here differences between IT teleworkers and nonteleworkers. All differences are statistically significant except where noted.

Forms of Telework

We found that 39.8% of IT workers report teleworking (less than one day per week to five days per week), mostly from home. Of those teleworkers who reported working at home, the majority of them do so less than one day per week (78.3%), whereas 21.7% report working from home one day per week or more. Of those teleworkers who reported working at telework centers or satellite offices, the majority of them do this less than one day per week (59.1%), whereas the remainder (40.9%) report teleworking one day per week or more. Finally, of those teleworkers who reported working on the road, 47.2% report doing this one day per week or more.

Table 1. Frequencies of demographic variables for IT teleworkers and nonteleworkers

Demographic Variable	Teleworkers: Percent of Total Teleworkers	Teleworkers: Male	Teleworkers: Female	Nonteleworkers: Percent of Total Nonteleworkers	Nonteleworkers: Male	Nonteleworkers: Female
Total sample[a]	39.8%	67.5%	32.5%	60.2%	55.9%	44.1%
Race						
American Indian	3.3%	58.3%	41.7%	3.1%	60.0%	40.0%
Asian	3.3%	58.3%	41.7%	7.1%	55.9%	44.1%
Asian Indian	3.0%	81.8%	18.2%	4.6%	81.8%	18.2%
Black	7.6%	53.6%	46.4%	9.1%	52.3%	47.7%
Hispanic	6.0%	72.7%	27.3%	6.0%	62.1%	37.9%
Native Hawaiian	0.5%	100%	0.0%	1.2%	66.7%	33.3%
White	75.7%	68.7%	31.3%	68.2%	54.0%	46.0%
Multiple race	0.5%	0.0%	100%	0.6%	66.7%	33.3%
Relationship status						
Single	21.8%	56.2%	43.8%	25.2%	44.6%	55.4%
Committed	78.2%	70.4%	29.6%	74.8%	59.7%	40.3%
Number of children						
None	38.6%	65.7%	34.3%	41.3%	54.6%	45.4%
One	19.5%	58.3%	41.7%	23.6%	50.5%	49.5%
Two	30.8%	71.9%	28.1%	25.5%	59.2%	40.8%
Three	7.3%	63.0%	37.0%	7.9%	64.9%	35.1%
Four or more	3.8%	100%	0.0%	1.7%	75.0%	25.0%
Highest degree						
High school	7.5%	50.0%	50.0%	8.9%	48.8%	51.2%
Vocational/ technical school	5.9%	72.7%	27.3%	7.7%	59.5%	40.5%
Associate's degree	10.4%	69.2%	30.8%	14.8%	50.7%	49.3%
Bachelor's degree	55.6%	66.8%	33.2%	53.4%	58.4%	41.6%
Master's degree	20.1%	72.0%	28.0%	14.3%	56.5%	43.5%
Doctorate degree	0.5%	100%	0.0%	0.8%	75.0%	25.0%
Salary						
$39,000 or less	5.4%	65.0%	35.0%	9.7%	47.8%	52.2%
$40,000 - $59,000	21.5%	50.6%	49.4%	31.1%	54.4%	45.6%
$60,000 - $79,000	26.9%	65.7%	34.3%	29.9%	57.4%	42.6%
$80,000 - $99,000	20.9%	74.0%	26.0%	19.5%	54.3%	45.7%
$100,000 or more	25.3%	78.5%	21.5%	9.7%	71.7%	28.3%
Type of IT position						
Conceptualizer	43.6%	65.6%	34.4%	27.7%	56.6%	43.4%
Developer	19.2%	69.6%	30.4%	20.4%	60.0%	40.0%
Modifier/Extender	8.3%	70.0%	30.0%	10.3%	58.3%	41.7%
Elder care						
Responsible	17.4%	66.1%	33.9%	19.0%	47.1%	52.9%
Not responsible	82.6%	67.7%	32.3%	81.0%	58.6%	41.4%
Individual vs. team work						
Work alone	42.7%	68.7%	31.3%	41.1%	54.3%	45.7%
Work on a team	57.3%	66.5%	33.5%	58.9%	57.2%	42.8%
Total hours worked per week						
39 or less	2.1%	0.0%	100%	6.0%	41.4%	58.6%
40 - 49	46.7%	65.1%	34.9%	59.0%	55.1%	44.9%
50 - 59	42.1%	70.3%	29.7%	29.2%	58.2%	41.8%
60 or more	9.1%	82.4%	17.6%	5.8%	67.9%	32.1%

[a] *Females comprise 39% of the sample; 36.3% of them telework. Males comprise 61% of the sample; 48.3% of them telework.*

Demographic Profile of Teleworkers

Gender

Females comprise 39% of the total sample; only about 1/3 (36.3%) of them telework (see Table 1). Males make up 61% of the total sample, nearly 1/2 (48.3%) of them telework. Consistent with national data (Davis & Polonko, 2001), male IT workers are more likely to telework than women.

Race

Whites were slightly more likely to telework, but there were no significant racial differences between teleworkers and nonteleworkers. The finding of racial balance in teleworking is consistent with national patterns (Davis & Polonko, 2001).

Relationship Status

We examined whether IT teleworkers tend to be single or in a committed relationship. We define "single" as those individuals who reported being single, divorced, or widowed and "committed" as those individuals who reported being married or living with their partner. Teleworkers and nonteleworkers were similar in their relationship status. These results mirror national data (Davis & Polonko, 2001).

Number of Children

Teleworkers and nonteleworkers were similar in the number of children they had. When examining only teleworkers, we found that the gender breakdown mirrored that of the overall sample; male teleworkers tended to have slightly more children (M = 1.29) than did female teleworkers (M = 1.02).

Highest Degree and Salary

Consistent with national patterns (Davis & Polonko, 2001), teleworkers had a higher educational level and a higher salary than nonteleworkers. IT workers in our sample were highly educated; most (71.7%) had at least a bachelor's degree. More than three-quarters of teleworkers (76.2%) had at least a bachelor's degree, while this was true for just over 2/3 of non-teleworkers (68.5%). This difference was not statistically significant. While males and females did not differ in terms of their highest earned degree, they did differ in terms of their salary; not surprisingly, males earned significantly more than females. When examining teleworkers only, men still earned higher salaries than women.

IT Position

Participants were asked to indicate their current IT position by selecting one of the following categories: conceptualizer, developer, modifier/extender, supporter/tender (see Key Terms). The breakdown was very different in terms of teleworkers vs. nonteleworkers. Proportionally more teleworkers were conceptualizers; proportionally more nonteleworkers worked in supporter/tender positions. These findings are not surprising because supporter/tender positions require IT workers to be in close proximity to the equipment and people they are responsible for supporting, whereas conceptualizer jobs do not. Supporter/tender positions may not allow the geographic and scheduling flexibility required of telework.

Elder Care

We were interested in whether or not teleworkers more than nonteleworkers chose telework because they were responsible for the care of an elder adult and needed the freedom to work from home. There were no significant differences in elder care between teleworkers and nonteleworkers.

Individual vs. Team Work

We asked participants whether they worked alone or as part of a team. We thought that the benefit of telework might be restricted to those who do not work with others. We found that teleworkers and nonteleworkers were similar in emphasis on individual vs. teamwork; the gender breakdown within this variable was similar as well. This finding lends support to the notion that even individuals who work in teams can telework.

Total Hours Worked

We examined the total number of hours worked per week by IT workers. Previous research suggests that one of the disadvantages of telework is that teleworkers tend to work more than nonteleworkers (Davis & Polonko, 2001; Mirchandani, 1998). The findings from the current sample support previous research; teleworkers in our sample worked significantly more hours per week (M = 48.55) than did nonteleworkers (M = 45.25). In addition, for the entire sample, males worked significantly more hours per week (M = 47.52) than did females (M = 45.42). However, when we examined the teleworker and non-teleworker samples independently, the gender results were different. In the teleworker sample, males worked significantly more hours per week (M = 49.37) than did females (M = 46.92). In the non-teleworker sample, there was no significant difference between males (M = 45.80) and females (M = 44.51) in the number of hours worked per week. These results are consistent with previous research that suggests that men and women use the extra time they save through teleworking in different ways. Males tend to use this time to do more job-related work, hence their longer working hours; whereas females may use this time to do more family-related work such as household chores (Steward, 2000).

CONCLUSION AND FUTURE TRENDS

Telework is a growing response to the need of organizations to reduce costs, enhance flexibility, and attract and retain workers with valuable skills. It is one way to create virtual teams and virtual organizations. Inexpensive information and telecommunications technologies and increasing global competition will accelerate this trend for IT organizations (Davis, 1995). IT workers, because they engage in knowledge work and are skillful at using information technology, are particularly well suited for telework.

Researchers are just discovering the consequences of telework and how to manage it effectively. Much telework research has been limited by reliance upon small convenience samples, poor measurement, inadequate statistical analysis of results, and inadequate grounding in organization theory (Bailey & Kurland, 2002). Management practice has lagged as well, with little understanding of how to alter organization structures and processes to make telework practice successful (International Telework Association and Council, 2000). There is a great need for well-designed research studies of telework in IT.

Women in many professions throughout the United States participate in telework. Women in our sample of IT workers participate extensively in telework as well, but when compared to men, they participate at a lower rate in comparison to national practice (IT teleworkers in our sample: 67% male, 33% female; national sample in U.S.: 54% male, 46% female; Davis & Polonko, 2001). This difference may be unique to the organizations in our sample. This difference also may be due to institutional barriers such as resistance to remote work among IT managers and work design barriers such as the need to tend to centrally located equipment around the clock. Future research should continue to explore gender differences in telework among IT workers and identify possible barriers and enablers. These results may then be used to help IT organizations and IT workers increase flexibility by distributing IT work away from the traditional office. This flexibility will enhance efforts to balance work and family needs as well as organizational competitiveness.

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KEY TERMS

Conceptualizer: Someone who conceives of and sketches out the basic nature of a computer system. Job titles include: product designer, research engineer, systems analyst, computer science researcher, requirements analyst, and system architect.

Developer: Someone who works on specifying, designing, constructing and testing information technology. Job titles include: system designer, programmer, software engineer, tester, computer engineer, microprocessor designer, and chip designer.

Distributed Work: Work that is distributed across geography and time. Distributed work may take several forms, (e.g., telework, telemedicine, virtual teams, and virtual organizations).

Knowledge Work: Work that consists of the creation and manipulation of ideas and symbols. Knowledge work is common in IT and is ideally suited for distributed work because it is easily digitized and may be done anywhere and anytime.

Modifier/Extender: Someone who modifies or adds on to already created information technology. Job titles include: maintenance programmer, programmer, software engineer, computer engineer, and database administrator.

Supporter/Tender: Someone who delivers, installs, operates, maintains or repairs information technology. Job titles include: system consultant, customer support specialist, help desk specialist, network installer, and network administrator

Telework: A type of distributed work in which employees work at locations other than the traditional workplace. Major types of telework include: (1) home-based telework–working from home; (2) satellite offices—employees from the same company work at the same location closer to their home, often in suburbs or exurbs; (3) telework centers–similar to a satellite office except that the telework center hosts employees from different organizations; (4) mobile work—working at multiple locations away from the office (e.g., at client work sites, while traveling).

Virtual Organization: A form of organization design in which organization structures and functions are distributed across time and geography.

Virtual Team: A form of work design in which members of the same work group are distributed across time and geography; usually compared to traditional collocated teams, where all team members are located at the same site.

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Gender and the Australian IT Industry

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INTRODUCTION

From its very beginnings in the post second world war years the information technology (IT) industry in Australia has exhibited gender stereotyping with the relegation of women to lower paid and lower status jobs. Unfortunately the words of Game and Pringle (1983) are as true today as when they were written more than twenty years ago:

The sexual division of labor is not a remnant from the feudal past that is gradually being eliminated, but is a fundamental structural feature of capitalist society. (p. 81)

The first IT projects were funded by the military when IT had a mathematics or science image. Neither of these characteristics was likely to make an IT occupation attractive to women. However some women were employed by small IT consultancies wanting to save money because in the 1950s in Australia, women were only paid around 75% of a male wage (Game & Pringle, 1983, p. 84). Opportunities arose for women to move into the IT industry in the late 1960s due to a skills shortage. However this had little long term impact as today women are still under-represented in the industry.

BACKGROUND

The trends over the three most recent census years (see Table 1) show little overall change in women's participation rate in the Australian IT industry. The drop of 2.6% in women's participation rate from 1996 to 2001 was at a time when the number of employees in the IT industry increased by 52%. The 2001 census data shows that few women are in management roles in IT in Australia. Also, as in most other occupations there are income disparities between men and women with women concentrated in lower income occupations. For a full discussion and analysis of the Australian IT industry data for the census years 1996 and 2001 see Byrne and Staehr (in press).

During the same period, the number of women with IT qualifications decreased by 6.3% despite the total number of persons with IT qualifications having increased by almost 70% between 1996 and 2001 (shown in Table 2).

The figures in Table 1 and Table 2 show that there are far fewer women working in the IT industry than there are women with post secondary school qualifications. Note that one reason for more woman with IT qualifications than women in IT occupations is that the women with occupations that come under the heading of education (e.g., secondary, TAFE, and university teachers) are not included in the figures in Table 1.

The number of women working in the IT industry is affected not only by the number of women gaining IT qualifications from universities, but also from Technical and Further Education (TAFE) Colleges

Table 1. The participation rates of women (WPR) in the Australian IT industry (ABS, 2002a)

Census Year	Women	Persons	WPR
1991	17370	72889	23.8%
1996	32733	126375	25.9%
2001	45408	192132	23.6%

Table 2. Post-secondary school qualifications in IT (ABS, 2002b)

Census Year	Women	Persons	%Women
1991	18986	51633	36.8%
1996	33114	90704	36.5%
2001	46707	153183	30.5%

and private education providers (e.g., Computer Power). In addition, there will be women both already in, and entering the IT industry without formal qualifications in IT. It is only since 1997 that membership of the Australian Computer Society (ACS) at the highest level normally requires formal IT qualifications. Accenture, a well known IT consulting company, advertises for graduates from Commerce, Law, Arts, Engineering, and Science as well as IT. Therefore, there are multiple pathways for women to enter the IT industry in Australia.

However, there is anecdotal evidence to show that women with IT qualifications are choosing to work in other occupations (Fisher, 2003). The figures in Table 2 are particularly disturbing since during this period the Australian Government and the universities made considerable effort to increase the participation and retention rates of women in IT education (Newmarch, Taylor-Steele, & Crupston, 2000). The actual numbers of women obtaining IT qualifications has increased from 1991 to 2001 but has not kept pace in relative terms with the overall employment trends in the Australian IT industry.

Thus, no matter how you look at it, the Australian IT industry is failing to attract/retain women and the situation is getting worse. Possible causes that have been identified are misconceptions about the nature of IT work, unfriendly male dominated workplaces, and the fact that long hours required by some IT work making it difficult to balance work and home responsibilities (Johnson & Miller, 2002; von Hellens & Nielsen, 2001). However, a close examination of the job roles available reveals that IT offers opportunities to work with people in a team environment, challenge and variety in work tasks, good pay and opportunities to travel, all attributes that women are likely to find attractive in a career.

One avenue for investigation of the under representation of women in IT is through an examination and comparison of the effect of individual company policies and government legislation on what women actually experience in the IT workplace. The national culture of an organization and public policy usually impact on company policies (Trauth, 2002; Trauth, Nielsen & von Hellens, 2000; von Hellens & Nielsen; 2001). For example, the culture of an American company located in Australia would be different to the culture of an Australian company within Australia. An example is an IT professional who was happier working for a Scandinavian company in Australia rather than an Australian company as she believed there was a strong workplace culture of equality coming from the Scandinavian head office (Trauth, Nielsen, & von Hellens, 2000; von Hellens & Nielsen, 2001). This suggests that company policies based on a culture of equality may positively affect an individual's workplace experiences. In contrast though, Woodfield's (2000) study of a software company in the United Kingdom found that although official company policies valued individuals with the right mix of skills regardless of sex, this did not necessarily match what happened in practice. And some people believe women are in the IT workplace to meet with government affirmative action legislation and not for their actual skills and abilities (Trauth, 2002).

It is claimed by Kirner and Raynor (1999, p. 170) that anti-discrimination laws are better accepted in Australia than in any other western country. Australia has had a Federal Equal Opportunity for Women in the Workplace Agency since 1986. This agency administers the Equal Opportunity for Women in the Workplace Act 1999. The Act requires companies with 100 or more employees to establish a workplace program to remove the barriers to women entering and advancing in the workplace and to report regularly to government. The sanctions for non-compliance are that the company will be named in parliament and the company will be ineligible to tender for government contracts and industry assistance. Companies with particularly good policies are eligible to win awards and have their names publicized in the media, providing incentives for companies to have woman-friendly workplace policies.

There are also a number of Australian Commonwealth, State and Territory government laws that make sexual harassment and discrimination unlawful (e.g., Sex Discrimination Act 1984 (Cth), Equal Opportunity Act 1995 (Vic). In addition, even Federal industrial laws seek to achieve anti-discrimina-

*Table 3. Background of participants (*participant names are pseudonyms)*

*Participant	Age at Graduation	Number of Years in the IT industry	Current Age of Children	Job Title at Time of Interview
Mary	Not Available			
Anne	40	7	18 years old and 20 years old	IT Officer
Sharon	29	6	3 years old and 13 months old	Business Analyst
Linda	22	9		Chief Operations Officer
Rachael	21	13	4 years old and pregnant at time of interview	Systems Administrator
Jane	22	4		Applications Support Programmer
Sara	22	5		Senior Internal Auditor
Vanessa	21	11		Senior Web Analyst/ Programmer
Kirsty	21	7		Area Specialist/Team Manager

tory objectives. For example, maternity leave provisions are included in the Workplace Relations Act 1996 (Cth).

SO, HOW DO WOMEN EXPERIENCE THE AUSTRALIAN IT WORKPLACE?

In a small exploratory qualitative study Bell and Staehr (2004a, 2004b) investigated how women experience the Australian IT workplace. The aims were threefold: to see if the same issues which women had identified in the past as barriers to working in IT were still a problem, to discover any new issues and to compare the women's experiences with company workplace policies and government legislation. The literature was examined and provided eight broad themes from which an interview protocol was developed. Interviews were conducted between November 2002 and April 2003. Company policies were either collected from participants or obtained from company Web pages.

Table 3 outlines the background of the nine participants in the study. Mary declined to be interviewed face to face, however she answered the interview questions via e-mail.

Table 4 shows the major themes that emerged from the analysis of the interviews and indicates where if at all, these themes were found in the existing literature. More detail on the two themes that have not previously been reported in the literature is given below.

Two participants who had young children felt that management had not supported them as mothers. In her current job, Rachael's management was unsupportive by only offering her twelve months of continuous maternity leave, although she knew she was entitled to a more flexible arrangement. Rachael had to leave a previous employer because her needs after her first maternity leave were not met. To accommodate her desire to both work and have a family, she has had to move to a lower paid job. When Sharon first starting working part-time she was removed from a team, as her manager did not want any part-time members. Sharon would like to reduce her time fraction further but her manager is unsupportive of her request.

Two of the participants mentioned difficulties when working with men of different cultural backgrounds. Sharon recalled when a colleague refused to converse with her on the telephone. According to Sharon, the attitudes of men who are not used to working with female colleagues in IT are poor. As Australian firms are outsourcing more and more projects overseas this sort of problem is likely to occur more frequently. Sara also noticed that men

Table 4. Major themes

Theme	Participant	Other Studies
Professional credibility	Mary, Anne, Linda, Jane, Kirsty	Teague (1998), Trauth et al. (2000), von Hellens et al. (2001).
Management support of women	Sharon, Sara, Kirsty, Linda	Webb (2002).
Management does not support mothers	Sharon, Rachael	
Difficulty of achieving a work-life balance	Vanessa, Kirsty, Sharon, Sara	Pringle et al. (2000), von Hellens & Nielsen (2001), Johnson & Miller (2002), Webb & Young (2005).
Lack of challenging work	Anne, Linda, Kirsty, Rachael, Sara	Hemenway (1995)
Difficulties of working with men from a different culture	Sharon, Sara	
"Boys club" culture	Rachael, Sara	Bruce & Adam (1990), Gill & Grint (1995); Hemenway (1995), Teague (1998), McCracken (2000), Nielsen et al. (2000), Pringle et al. (2000), Suriya & Panteli (2000), Trauth et al. (2000), von Hellens et al. (2001), von Hellens & Nielsen (2001), Webb & Young (2005).

from different cultures treat women inappropriately. According to Sara, being a woman and asking questions or addressing management is unacceptable behaviour in certain cultures.

During the interviews, five of the participants reported that they had given thought to leaving their current employer due to the work not being challenging enough. It was reported by Panteli, Stack, Atkinson, and Ramsay, (1999) that lack of challenge in a current IT position is the most often quoted reason for both men and women to leave an employer. However, it is given as a reason more often by women than men.

Seven of the participants were able to share with the researcher their current workplace policies. However, the experiences of five participants did not match that of their workplace policies and/or government legislation and are summarised in Table 5.

Workplace policies and government legislation do not seem to guarantee fair treatment for women in the Australian IT workplace. Interestingly, the company where Rachael currently works has won an award for its workplace policies.

All of these women worked for companies that needed to conform to government requirements for workplace policies for women. At the time of writing the requirement is only to have policies in place but there is no compulsion for companies to ensure that the policies are actually achieving benefits for women. Organisations need to make sure individual managers are informed about the policies, and that measures are put in place to ensure adherence to them.

FUTURE TRENDS

The failure to increase the participation rate of women in the Australian IT industry over the last ten years is a disturbing trend. Unfortunately there seems to be a prevailing attitude that this battle has already been fought and won. Our small study showed that some women today are still finding some aspects of the IT workplace an unfriendly place for women. Problems where women were working with men from other cultures are not surprising due to the recent increase in off-shoring of IT work and an increasingly more multicultural society in Australia. Management need to be aware of the problems that women may encounter in these situations.

Government legislation and workplace policies designed to improve workplace conditions for women do not seem to be having an effect. Unfortunately, most Australian employers see equal opportunity for women as a risk management issue that reduces legal exposure. Equal opportunity needs to be seen as a strategic business initiative that will increase profits (Why EO Makes Good Business Sense, 2004). Until employers get the message that providing a woman-friendly workplace can attract high

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Table 5. Participant experiences matched with relevant legislation and/or company policy

Participant	Experience	Relevant Government Legislation or Workplace Policy	Country Of Origin Of Current Employer
Mary	Sexual harassment	Sex Discrimination Act 1984 (Cth).	Unknown
Anne	Sexual harassment	Sex Discrimination Act 1984 (Cth).	Australia
	Not being given challenging tasks.	Equity and Diversity Plan - "…everyone should be given an equal chance to make the most of their own talents and use their abilities".	
Sharon	Not able to reduce her time fraction.	Part-time employment policy.	USA
Rachael	Pressured to apply for a continuous twelve month maternity leave period rather than take two six months periods.	Workplace Relations Act 1996 (Cth) Enterprise Bargaining Agreement – "An employee shall be entitled to extend the period of maternity leave".	Australia
Jane	Not being selected to work on development projects. Therefore overlooked for career advancement.	Affirmative Action (Equal Employment Opportunity For Women) Act 1986 (Cth) Equal Opportunity Act 1995 (Vic) Workplace Diversity Policy – "Affirmative action is about identifying and addressing the barriers that prevent women from entering or advancing in the workplace."	Australia
Sara	Not able to achieve a healthy work-life balance	Company Internet – "a healthy work/life balance and employee diversity are valued".	Australia

quality employees and increase profits there is not likely to be an increase in women's participation rate in the Australian IT industry.

CONCLUSION

Some of the issues raised by the women in our study of the IT work place confirm the findings of previous research. However the difficulty of working with men from a different culture, lack of support for mothers and the lack of challenging work affecting job satisfaction have not previously been reported in the Australian context.

More work is required to confirm the findings of this research. Future work will involve the study of both male and female IT professionals in several organizations with the aim of comparing their experiences with workplace policies and government legislation. Another planned research direction is to identify the best ways for organizations to successfully implement women-friendly policies.

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KEY TERMS

Affirmative Action: In the context of employment it involves pro-active steps taken by an employer to ensure the provision of equal employment opportunity.

Equal Opportunity: Equal opportunity (EO) in a workplace context means that all employees have equal access to the opportunities that are available at work. This means all employees are treated with fairness and respect in that they are not subject to discrimination or harassment in the workplace". (Source: Retrieved February 6, 2006, from http://www.eowa.gov.au/About_Equal_Opportunity.asp)

Gender Stereotyping: In the context of occupations, some jobs in some societies are considered only suitable for males or only suitable for females.

Post Secondary School Qualifications: Are grouped by the Australian Bureau of Statistics Classification of Qualifications into:

- **Bachelor Degree and above:** Bachelor degree (including honours), graduate or postgraduate diploma, master's degree or doctorate
- **Undergraduate Diploma:** Courses lasting three years full-time (or equivalent) for professional or associate professional occupations
- **Associate Diploma:** One to two years full-time (or equivalent) for advanced trades, technical or associate professional occupations
- **Skilled Vocational Qualification:** Two to four years study for work in a high skilled trade or craft
- **Basic Vocational Qualification:** One semester to one year study for work at the operative level in various fields

Sex Discrimination: "Occurs when a person is treated less fairly than another person because of their sex or marital status or because they are pregnant. This is direct discrimination. Indirect discrimination can also occur when a requirement that is the same for everyone has an unfair effect on some people because of their sex, marital status, pregnancy, or potential pregnancy."(Source: Retrieved February 6, 2006, from http://www.acas.org.uk/faqs/discrimination.html#5)

Sexual Harassment: "Sexual harassment is any unwanted or uninvited sexual behavior which is offensive, embarrassing, intimidating or humiliating. It has nothing to do with mutual attraction or friendship." (Source: Retrieved February 6, 2006, from http://www.apesma.asn.au/adviceonline/entitlements/discrimination. htm#SEX%20 DISCRIMINATION)

Women's Participation Rate: The percentage of women as a proportion of the total number of persons employed in IT occupations in Australia.

Gender and the Culture of Computing in Applied IT Education

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INTRODUCTION

The "shrinking pipeline" of women who ascend through the ranks in computer science education programs and careers is by now a familiar problem. Women drop out at rates faster than men at all levels of educational and professional advancement, resulting in a gender gap especially pronounced at the highest levels of the computing workforce, and that has not narrowed appreciably at any level in more than 20 years (Camp, 1997; ITAA, 2005; Vegso, 2005). Efforts to move more women into the pipeline at lower levels have met with limited success (cf. the Carnegie Mellon experience as reported by Margolis & Fisher, 2002); girls and women still express less interest than boys and men in studying computer science and pursuing information technology (IT) careers (Bentson, 2000; Vegso, 2005).

A reason often cited in the literature is the masculine culture of many computer science programs and IT workplaces, which is perceived by many women as alien and unwelcoming (Bentson, 2000; Spertus, 1991; Turkle, 1988). Even when institutions make efforts to treat women and men equally or accord women special consideration in admissions and hiring decisions, attitudes discouraging women from entering computing persist, both within the institutions and in society at large. Sometimes these attitudes are expressed overtly: Underground "hacker" culture is notoriously antagonistic to women (Gilboa, 1996), and even mainstream computer aficionados respond with resistance and sexist jokes to proposals to recruit more girls and women to study computer science (Slashdot.org, 2005). Moreover, there is a widespread perception that computer experts are socially-isolated "geeks" or "nerds" obsessed with technology, a mode of being that women, who tend to be more socially oriented, find unappealing (Margolis & Fisher, 2002; Turkle, 1988).

Fortunately, the situation for computer science does not tell the whole story. In the latter part of the 20th century, the expansion of computing and the Internet fueled the rise of applied IT fields in which technical skills, rather than being developed for their own sake, are increasingly put to use in the service of human needs. Applied fields, such as information science, information systems and instructional technology, have gained strength, and a new interdisciplinary field, informatics, has emerged. At the same time, interest in computer science itself is declining, especially among women (ITAA, 2005; Vegso, 2005). In this article, we explore the possibility that applied IT fields may provide more women-friendly cultures while still focused on technology. The larger question underlying this exploration is: Does applied IT education have the potential to bridge the "gender computing gap"?

BACKGROUND

Previous research has focused primarily on problems faced by women in computer science, especially in undergraduate-level education (Camp, 1997; Cohoon, 2001; Spertus, 1991). Many influences have been cited as contributing to the educational gender gap in computer science, including aspects of institutional culture, such as lack of role models (Pearl, Pollack, Riskin, Thomas, Wolf, & Wu, 1990), mentoring and advising (Whitely, Dougherty, & Dreher, 1991), informal networking (Smith-Lovin & McPherson, 1993) and a sense of belonging and identity (Ely, 1995); work-family conflict (Netemeyer, Boles, & McMurrian, 1996); and teaching styles (Cohoon, 2001; Turkle, 1988).

One of the most often-cited factors that discourage girls and women from studying computer science is the culture of computing itself: Computing is historically and conventionally associated with masculinity, an association that attracts boys to computers who then become role models for other boys, creating environments in which girls feel marginalized (Hacker, 1990; Turkle, 1988). Citing Margolis and Fisher (2002), Read (2002) argues that "women are further alienated by a stifling 'geek culture' that celebrates obsessive computing at the expense of broad interests." Hackers are perceived as keeping exceptionally long hours and late nights, and manifesting "highly focused, almost obsessive behavior" (Frenkel, 1990, p. 38). For many women, this work ethic conflicts with their desire to start a family or, if they are older, their actual family responsibilities. Meanwhile, hackers, who are predominantly male, are seen as being "bright and creative," while women remain on the periphery. Rasmussen and Hapnes (1991) suggest that this type of culture is important in producing and reproducing male domination in higher education in computer-related fields and that it influences the integration of women and their position within the field of computing.

The abstractness of much computer science instruction exacerbates the gender-biased culture, in that girls are more likely to be interested in real-world problem solving in contexts involving human users than in machines and programming languages (Clarke, 1992). A related deterrent for women is that most introductory computer science courses focus on programming skills rather than concepts of computer science. Girls and women like IT, the findings suggest, but want to do something with it to improve the world; they are not satisfied with mastering computing skills for their own sake.

Applied fields such as information science, information systems and instructional technology have an a priori advantage over computer science when it comes to attracting future female professionals. They are grounded in the disciplines of real-world problems; for example, business, education and information management. Indeed, while women are significantly underrepresented in the IT workforce overall (ITAA, 2005), especially in computer science (Bryant & Vardi, 2002), applied careers, such as education and library and information science, attract higher proportions of women (e.g., Maata, 2003). However, research on the status of women in these professions shows mixed outcomes. On the one hand, women in applied disciplines are more likely to achieve professional parity or near parity with men (Quint, 1999; Wolverton, 1999). On the other hand, even in female-predominant applied professions such as education and library science, most high-ranking administrators are men (Growe & Montgomery, 2000; McDermott, 1998). Moreover, men tend to be disproportionately represented in IT work in these fields, which also tends to be more highly paid and more prestigious (e.g., Harris, 2000 for library and information science).

Little has been written about what leads women (or men) to choose applied IT careers, or what kinds of disciplinary cultures they encounter when they decide to study an applied IT domain. That is, there is no body of literature directly comparable to that available for computer science on which to base predictions about the long-term effects of the growth of applied IT fields on the gender computing gap. To address this research gap, we initiated the Information Technology Workforce (ITWF) project.

INFORMATION TECHNOLOGY WORKFORCE PROJECT

The ITWF project, funded by the National Science Foundation,[1] has been collecting and analyzing data on the experiences, attitudes and outcomes of women and men in IT programs at five large public universities in the United States (U.S.)[2] since September 2003. The focus is on students at all levels majoring in applied IT disciplines, specifically: information systems (IS), instructional systems technology (IST), informatics (I) and library and information science/

studies (LIS). We expected to find differences among these fields and between applied fields and computer science (CS); more generally, we expected that more female-oriented ("women-friendly") disciplinary cultures would produce more successful outcomes (Jones, 1990), where success is defined both in terms of the quantity of women who enter IT-related educational programs and the quality of their educational experiences (Ahuja, Herring, Ogan, & Robinson, 2004).

Data collection for the project as a whole is via Web-based surveys, telephone interviews and face-to-face interviews with students, faculty and staff in the IT programs. In this article, we focus on findings from an initial Web survey of all IT student majors in the five universities (from the four applied IT fields plus computer science) that took place in spring 2004. The survey asked 100 questions about students' experience, behaviors and attitudes regarding computers; their parents' occupations and attitudes toward gender roles; student demographic information; and information about mentoring, stress and burnout in their academic environment.[3]

SELECTED FINDINGS

The results of the survey were revealing of the attitudes and experiences that influence students in their selection of an IT career. Three distinct patterns emerged, showing variation according to gender, IT discipline and the interaction between gender and discipline.

Gender-Based Variation

For some survey questions, men and women tended to answer differently, regardless of their program of IT study.[4] For example, one question asked students to assess the relative importance they place on their career and their personal life. While most people answered that the two are equally important, females were more likely to choose the balanced response, while males were more likely to say that their careers are more important. This is consistent with previous observations that men in IT are more focused on their work, while women seek a more balanced lifestyle (Frenkel, 1990; Margolis & Fisher, 2002).

Another series of questions asked about work/life balance as a potential cause of stress. Most students answered "occasionally" or "seldom" to questions about whether schoolwork interferes with personal life and vice versa. However, women were more likely to say that school strain affects their personal life all the time, and men were more likely to respond that it never does. This could be a reflection of female students having greater domestic responsibilities (Netemeyer et al., 1996); more of the female than male survey respondents said they were married and/or had children at home.

Unsurprisingly, most of the IT students reported that they feel very comfortable using computers. However, here, too, a gender pattern is evident. Males in all majors were more likely to answer that they are very comfortable, whereas females gave most of the "somewhat comfortable" or "not at all comfortable" responses; this includes women in CS. Women also reported learning to use computers later than men, and playing fewer computer games when they were children.[5]

These results support previous findings on gender differences in early computer experience and in computer self-efficacy (Durndell & Haag, 2002; Fromme, 2003), suggesting that some manifestations of the gender computing gap persist in applied IT disciplines.

Discipline-Based Variation

Differences are also evident within the IT disciplines, independent of respondent gender. A common tendency was for responses for LIS and IST to pattern together, in contrast to responses for CS and IS, with informatics falling in between. For example, when asked to weigh the relative importance of their career vs. their personal life, students in IS and CS were more likely to indicate that career was more important, and students in LIS and IST were more likely to say that their personal lives mattered more. Perhaps not coincidentally, students in IST and LIS also expressed greater satisfaction with their majors than did the IS and CS students.

Conversely, when asked what attracted them to their IT career choice, students in IS singled out earning a good living, and students in CS cited the challenge inherent in the subject matter. These considerations were rated less important by students in IST and LIS, for whom helping others was the highest consideration.

Disciplinary differences were also found with regard to students' backgrounds and childhood experiences. CS and IS students were more likely to have had a father and/or mother who worked in an IT-related profession. CS, IS and informatics students clustered together in terms of where and when they first started using computers (at home, before or during their elementary school years) and the amount they played computer games as children ("very frequently" or "frequently"). Of those who answered that they did not learn to use a computer until high school or college, and played games "rarely" or "never," most were from IST and LIS.

When asked what kind of job they expected to find after graduation, a majority of the respondents, with the exception of IST students, answered "scientific or technical." In addition, CS students preferentially indicated "university teaching and research," and IS students indicated "administrative/managerial," "consulting" and "sales." IST students responded "consulting" and "K-12 teaching," and LIS students indicated "administrative/managerial," "clerical" and "other." It is hardly surprising that different disciplines target different careers; however, the students' career expectations in CS and IS (e.g., industry researcher, professor) tend to be higher status and better paid than those in IST and LIS (e.g., K-12 teaching, clerical). Computer science and business are traditionally "masculine" fields, whereas education and library science are traditionally considered "feminine" professions.

Gender and Discipline Variation

In the third pattern of survey results, gender and IT discipline interact. Specifically, males in traditionally masculine disciplines tend to pattern together with females in traditionally feminine disciplines, and females in traditionally masculine disciplines pattern together with males in traditionally feminine disciplines. These results suggest a natural mapping between the gender of the student and the traditional gender associations of the discipline.

For example, the survey asked students to indicate their degree of satisfaction with their major. While most answered "very satisfied," CS men and IST/LIS women were overrepresented on that response. The inverse pattern was found for the less-enthusiastic response "somewhat satisfied": CS women and IST/LIS men were overrepresented. In particular, women in IST and LIS selected "very satisfied" much more often than did women in CS, consistent with our expectations that IST and LIS are more "women-friendly" cultures (Jones, 1990).

Or consider another set of results, in response to the question, "How similar are your values to those of your field?" IS males and IST/LIS females were most likely to answer "very similar," and informatics females and IST/LIS males were most likely to answer "not at all similar." If we consider informatics to be part of the CS/IS cluster, this instantiates the same pattern.

Students' confidence about finding a job after graduation displays a similar cross-distribution. Males in CS and females in IST/LIS were most likely to answer that it will be "very easy" to find a job; LIS males and male students in CS and informatics were most likely to answer "very hard," and women in CS and informatics were overrepresented in the "don't know" category. There seem to be two types of male CS student; those who are very confident and those who are more pessimistic about their job prospects. Apart from this, these results also fit the tendency for confidence and satisfaction to accompany a mapping of student gender onto IT discipline.

DISCUSSION

The results of a Web-based survey of students in different IT programs in five U.S. universities reveal gender differences among students, differences among IT disciplines and a mapping of gender onto disciplinary cultures, all of which potentially affect students' choice of and satisfaction with an IT career. Rather than clustering together in contrast to CS, the responses of students in applied IT programs tended to fall out along gender and disciplinary lines, with CS and IS clustering at one end, and LIS and IST at the other; informatics, the new discipline, mostly fell in between.

Somewhat discouragingly, the women in the applied IT programs, like the women in computer science, report having less early computer experience and less confidence in their computing abilities than their male peers (Ogan, Ahuja, Robinson, & Herring, in press). At the same time, the female students' reported preference for a balanced lifestyle may help to explain why more women choose applied IT majors than CS. The most popular IT majors among women in our study are those that are traditionally feminine, in which there are more women peers and role models, and which value using technology to help people. Fewer women choose IT majors where the focus is on technology for its own sake (in the case of CS) or making money (in the case of IS),[6] although the women who choose those majors appear to do so for those reasons, similar to men. Most intriguingly, both genders report greater satisfaction with and optimism about their career choices in IT disciplines that mirror the gendered cultures found in society at large.

FUTURE TRENDS

These findings are simultaneously encouraging and problematic. On the one hand, they suggest that the rise of applied IT fields does indeed open the door to more women studying and working in IT. Specifically, the findings indicate that IT programs located in traditionally "women-friendly" contexts may be more accessible and appealing to women, and by extension, that other IT contexts might evolve to become more women-friendly as well. Informatics is an example of a discipline whose culture has not yet become fixed; in this study, it tended to pattern weakly with CS and IS, but that tendency could shift.

At the same time, the survey findings are problematic in that they re-inscribe cultural stereotypes about gender roles and interests in the IT domain. Moreover, a positive interpretation of the results assumes an equivalence between the various IT fields that is more illusory than real. "Feminized" professions such as instructional design and librarianship still have less status and are lower paid, even when they incorporate IT (Lorenzen, 2002). Moreover, the computing technology involved is typically less rigorous than in computer science (e.g., it may not require practitioners to know how to program a computer). Does women's greater satisfaction with applied IT programs help to bridge the gender IT gap, or does it reproduce a larger societal status quo, of women as less technology- and career-oriented?

Ideally, IT study should be equally accessible and rewarding for women interested in hard-core computing and men interested in human applications as it is for men interested in, for example, grid structures, or women interested in information management or educational applications. Again, informatics may help to bridge the gap if a culture can be forged in which technical rigor is balanced with a focus on computing applications that benefit people.

CONCLUSION

This study has raised a previously unasked question about the potential of applied IT fields to close the gender computing gap. The question remains, for the most part, unanswered; further research needs to be done, for example, to compare the IT content of applied IT programs, and to take national culture (in addition to disciplinary culture) into account in assessing the appeal and outcomes of different approaches to IT. In the meantime, enrollments in CS are declining in U.S. universities (Vegso, 2005) and the IT workforce is aging (ITAA, 2005), but society's need for IT expertise remains high. In the future, it is likely that career seekers of both genders will turn increasingly to applied IT and to the new interdisciplinary paradigms emerging from combinations of computing, information studies and other fields (Berghel & Sallach, 2004). It is important to understand the social dynamics and implications of these trends, in the hope that we may be able to shape them into gender-equitable configurations.

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KEY TERMS

Applied IT: Programs of study and careers in which information technology is applied in contexts of use; for example, business, education, libraries.

Computer Science (CS): In this article, a university program teaching computer science.

Gender Computing Gap: The relative absence of women in computing-related programs of study and careers, especially computer science.

Informatics (I): A new interdisciplinary area of study in the U.S., with roots in computing applications to medicine, and university programs that teach it.

Information Systems (IS): In this article, a university program teaching information systems; usually associated with Management in Business Schools.

Instructional Technology (IT): In this article, a university program teaching instructional technology; typically found in Schools of Education.

Library and Information Science/Studies (LIS): In this article, an academic program teaching library science, information science and/or other information management skills.

ENDNOTES

1. National Science Foundation IT Workforce Grant #0305859, "Toward Gender Equitable Outcomes in Higher Education: Beyond Computer Science."
2. Universities were selected that offered computer science plus a minimum of two applied IT programs.

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[3] 1,768 students responded to the survey, of whom 1,516 indicated their gender.

[4] A "finding" in this article indicates a result for which a gender or discipline had values well above the mean for the specified discipline, based on descriptive statistics. Statistical significance was not measured and no claims of significant differences are made.

[5] See Ogan et al. (in press) for more detailed discussion of gender differences in the survey responses.

[6] Women are seriously underrepresented in both business information systems and computer science programs in our sample.

Gender and the Household Internet

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INTRODUCTION

Internet research has reached a point where a detailed analysis of household Internet use is necessary. Given that the household is a contested terrain for feminist theorists (Hochschild, 1989; Luxton, 1980), it is often a site of struggle between household members and a place where unequal divisions of domestic labour situate women as bearing the load of housework and caregiving (Cockburn & Furst-Dilic, 1997). How should researchers examine Internet use in the household?

There are two particular areas that need to be considered in order to contextualize household Internet use. The first is household roles: the interactions and relationships shaped by societal expectations and social roles (gender, class, and race). The second is the domestic division of labour: Who is responsible for domestic tasks and how does this influence household Internet use?

BACKGROUND

Previous research has begun to address notions of computers or the Internet in the home (Bakardjieva & Smith, 2001; Cumming & Kraut, 2001; Dryburgh, 2001; Habib & Cornford, 2001; Haythornwaite & Kazmer, 2002). However, they often do not examine everyday lived household experiences and their implications on the relationships between men and women, social roles, the division of labour, social interaction, and relationships in the household. Often, researchers do not connect these contexts to broader social relations such as race, class, and gender, and the relations of power inherent within the household.

The introduction of computers in the home in the 1980s (Frohlich & Kraut, 2002; Lally, 2002) notes the changing nature of computer use in the household context. In the 1980s, the few home computers that existed were used for word processing, telework, bringing work home, and children's games (Venkatesh, 1996). However, in the 1990s, it is evident that the nature of computer use changed and adapted to the household as it became domesticated; education, family communication, family recreation and travel, shopping, and domestic finances were common computer uses (Venkatesh).

Literature concerning the Internet in the home is often framed around how it has become domesticated, though this term seems to mean different things to different researchers and through different processes. What does it really mean? Domesticating something (an animal or person) denotes discipline, taming or civilizing, or making something fit for life in the home or able to participate in society (Habib & Cornford, 2001). Domestication can be conceptualized as shaping the use of technology in order to fit the household so that the technology eventually becomes embedded and almost invisible (Rommes, 2002). It is the way technology influences the user, and the user influences technology (Rommes). Information and communication technologies are often domesticated to serve people's own values and interests (Dutton, 1999). This indicates that the domestication of the Internet can vary from household to household, and the household is a continual site of cultural struggle over the meaning of the technology and what it should be used for (Murdock, Hartmann, & Gray, 1995). There is a need to better understand the process of domestication, which situates technology in diverse ways within the household (Silverstone, 1993).

MAIN THRUST OF THE ARTICLE

Household Roles

What must first be understood about household Internet use are the roles or the expectations that people have of one another in the household. Roles within the home are gendered and reflect race and class, and are often reinforced and strengthened through social interaction between people (West & Zimmerman, 1987). For example, there are existing social arrangements, cultural conditions, and practices that surround household technologies (Ribak, 2001), and the Internet in the household must be examined with this in mind. Examining how the household Internet is becoming domesticated should also address how a technology shapes and becomes a part of one's gender identity, and how women and men often relate to stereotypical images of gender identity (such as men being technologically competent; Rommes, 2002).

Women and men use the Internet differently and in different amounts because of social expectations guided by gender roles. Women utilize the Internet in ways that reflect their everyday gendered household roles (Shade, 2004); they are the communicators and networkers, and spend considerable time e-mailing family and friends more so than men (Kennedy, Wellman, & Klement, 2003). In contrast, men's use of the Internet is often less social as they spend more time searching for information and pursuing more isolated recreational activities.

Relations of power are important both in instances between parents, and parents and children, but also between those who have better Internet skills and those who do not. For example, it is often stated that women are less comfortable with technology than men (Ribak, 2001; Singh, 2001; Wajcman, 1991), thus they leave technological "fix-its" to others or use the technology less. As well, children's knowledge of the Internet often surpasses their parents'. In cases in which a household has only one computer, relations of power, based on skill or comfort, have an impact on the amount of time household members might spend on the Internet and who feels they are entitled to use it more. While there might be a power relationship between parents regulating children's use, the power is reversed when children are able to maintain and modify the household computer (Frohlich & Kraut, 2002).

As well, competition and struggle (Ribak, 2001) over the household Internet needs to be considered. Hierarchies of access and time available for household members will ultimately affect its use. Issues such as who can get on the Internet, at what time, and for how long are just as significant as what they do once they are online (Frohlich & Kraut, 2002). The question becomes what type of use by various household members is most important. Is this contingent on household roles? Internet use based on work or school becomes prioritized over leisure, with many households accepting this hierarchy (Ribak, 2001). How are these practices established? How are they negotiated or how do they change over time? Are households with one computer scheduling Internet time? If so, what is this process and who is responsible? The coordination and scheduling of Internet use is rather fuzzy; is there a daily routine or is it unpredictable (Frohlich & Kraut)? As well, how prevalent is the existence of multiple computers with Internet access in the home? Can multiple computers with Internet access address issues of contention among household members? Does this promote more individual use rather than collective household use?

Parental roles are also important. The presence of children in the household adds to the responsibility of parents in terms of Internet use. Perceptions of the Internet shapes parental concern over what children may be doing online, and how much time they are allowed to spend playing games, surfing, or chatting becomes an issue for many parents. There is little detail on who is responsible for children's Internet use within the household. One could speculate that women may be more responsible because they are the primary caregivers. However, it can also be said that men might be responsible for governing household technology such as the Internet (as technology is said to be masculine). It is difficult to say as there is little research on whether one parent is solely responsible; studies generally discuss the parents collectively (Frohlich & Kraut, 2002).

The Domestic Division of Labour

Household roles encompass not only gender roles, but also the roles of parents and children, and these roles are also framed by domestic labour. The word domestic is often associated with unpaid work in the household or homemaking, which is divided by the different jobs that women and men do (Habib & Cornford, 2001). Domestic labour (unpaid work) involves such tasks as cooking, cleaning, washing, shopping, emotional care of the husband, and child care (Wajcman, 1991). The household division of labour often presumes that women are responsible for this domestic work (West & Zimmerman, 1987) as gender is important in household maintenance and how domestic work is allocated (VanEvery, 1997). Women do more work in the home than men (Hochschild, 1989; Luxton, 1980; Robinson & Godbey, 1997; Shelton & John, 1996), and the amount of domestic work increases for women with the presence of spouses and children (McMahon, 1999; Wajcman). Men are considered helpers rather than sharers in the domestic sphere (McMahon), indicating that domestic work is still perceived as women's responsibility.

Considering the differences between women and men on time spent on household responsibilities, it is worthwhile to consider what the implications are on household Internet use. The interactive processes between husband and wife, and the gender ideology (Komter, 1989) that rests within the home, are important factors to consider when examining the domestic division of labour. While not every household is identical (Hochschild, 1989), depending on race and class (Calliste, 1996; Cohn, 2000; McMahon, 1999), there are overwhelming similarities between heterosexual households.

Feminist literature concerning technology in the home is often useful as a framework because it focuses on the importance of social roles, the hierarchy of these roles, and the relationships of power between women and men in relation to technological skills and use (Cowan, 1983, 1987, 1999). There are often expectations that domestic technology will be labour- and time-saving devices that alleviate women's domestic responsibilities, but this has not been the case (Wajcman, 1991). As the Internet in the household has been discussed within the context of domestication, it is useful to consider some of the previous arguments concerning domestic technology such as the washing machine, microwave, dishwasher, and so forth, and how these affect household members. Is the household Internet any different? If indeed the Internet has become domesticated, we need to consider what this really means to household members, and whether the household Internet exacerbates gender stereotypes and the domestic division of labour or challenges them. What further expectations are there upon women and men in the household with the presence of the Internet?

Given that women are primarily responsible for domestic labour, women will have less time for Internet use. In terms of time available, women with children spend less time communicating and searching for information than men do (Kennedy et al., 2003). Time is an important factor when considering household Internet use. Domestic labour takes time, and therefore less time is available for those responsible for domestic work. Previous research has shown that both women and men with children at home spend less time talking on the phone, reading the newspaper, watching television, and attending cultural events (Robinson & Godbey, 1997). Since women are the primary caregivers of children in the home, Internet use in the home should reflect this status. For example, seeking support from other mothers and offering support through e-mail, Listserv, and instant messaging are important to mothers (Bakardjieva & Smith, 2001; Miyata, 2002).

Furthermore, women's use of technology in the household is often functional so that work is done more efficiently and quickly (Frissen, 1992). Women tend to use it more instrumentally in such instances as helping children with homework and communicating with family and friends, thereby using it as a tool (Singh, 2001). Women are less concerned with mastering the technology or using it for recreation—as a toy—than men are (Singh; Turkle, 1984). Therefore, gender and household roles play an important role in household Internet use. Needless to say, class and race are important as well, yet these are rarely discussed as contextual within the literature.

As well, the kinds of information that women seek online also reflect their caregiver status. More women than men seek health information online, with women twice as likely to seek health information for their children (Shade, 2004). Women's responsibility as caregivers is clearly reflected in the kinds of information they seek online. However, existing literature does not seem to make the connection between domestic responsibilities and Internet use, or it does not present the connection as important or relevant.

FUTURE TRENDS

What also needs to be considered is the flip side of the situation, or how the presence of the Internet in the home has changed or challenged the current structure of the household. For example, De Haan and Huysmans (2002) argue that "home Internet users spend two hours less on paid work and almost two hours less on childcare and domestic tasks" (p. 83), and they claim that Internet users have more free time than nonusers. However, it is not clear why; does using the Internet in the household save time on other tasks? Do households lower their cleanliness standards? Other researchers indicate that parents who are users of the Internet spend more time on child care, less time sleeping, and more time on hobbies (Fu, Wang, & Qiu, 2002). Some researchers (Cranmer, 2000; Livingstone, 1992; Wheelock, 1992) have examined how individuals negotiate (and renegotiate) their gender identity in relation to technology and other household members, which is important in understanding the reciprocal relationship between people and (in this case) the Internet.

Additional research using interviews and participant observation would be useful in understanding the modern household and Internet use, and would situate broader processes into the domestic context (Morley & Silverstone, 1990). As Shade (2004) argues, quantitative data only presents a snapshot of the big picture in terms of the factors affecting household Internet use. How do social meanings of the household Internet come into being? Therefore, the goal of future Internet studies should move beyond quantifying and predicting Internet use (Singh, 2001) to a more comprehensive analysis that involves recognizing the contexts, both micro and macro, of household Internet use.

CONCLUSION

Existing literature focuses on who uses the Internet, how often, and in what way, but gives little on why it is used within the household context. The existence of roles and expectations, formulated around gender, race, and class, and the division of labour are clearly factors that must be examined to understand the diversity of household Internet use. Clearly, when studying a household technology, domestic context is important.

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KEY TERMS

Domestication: Refers to the process of adapting something to the household. For example, pets are tamed or trained to adapt to being in a household. In relation to technology, it means adapting the technology to suit the routine and expectations of the household and its members.

Domestic Labour: Refers to unpaid jobs or tasks relative to the household that are divided up between women and men. For women, such jobs include cooking and baking, laundry and cleaning, child care, and emotional care giving. For men, such jobs include yard work, and home repair and maintenance.

Domestic Technology: Refers to specific types of technologies that are located in the home and used in relation to daily household chores or responsibilities. These include washing machines and dryers, refrigerators, microwaves, ovens, and so forth.

Gender: Refers to performative, socially constructed scripts of women's and men's behaviour and characteristics that are deemed either feminine or masculine. These characteristics are culturally and historically specific, and are not the same as biological sex.

Household: Refers to where people primarily reside and is used to reflect the diversity of family types in our society today. The term family comes with much cultural baggage and denotes a heterosexual nuclear family. There is not one monolithic type of family but many different family arrangements (depending on class and race as well as sexuality) including single parents; gay, lesbian, and bisexual families; extended families; and so forth. As well, home denotes a safe haven or space, which is not necessarily the case given the prevalence of domestic violence and abuse.

Household Roles: Refers to such roles as mother, father, sister, brother, and so forth, which come with expectations of behaviour and responsibility based upon gender and hierarchy. For example, mothers are expected to be the primary caregivers to children. As well, Internet use by either parent for work may be deemed as more important than leisure use by children.

Internet: Refers to things people do online such as communication (e-mail, instant messenger, and so forth), information seeking, commerce (purchasing products), and entertainment (games).

Gender and the Internet User

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INTRODUCTION

Civilization has seen an explosion of information technologies over the last one hundred years. The telephone, radio, television, and Internet have entered the lives of men and women at work and home, becoming the main forms of communication and entertainment. Unfortunately, early adopters and creators of these technologies were men. Women, working primarily in the home, were not exposed to these technological innovations until husbands or fathers brought them into the home. Oftentimes, wives and daughters viewed these "contraptions" as intrusive to the harmony of the home. Therefore, in order to appeal to the widest possible audience these information technologies were adapted, mostly by corporations, to appeal to women through aesthetically pleasing design, creative programming, and product marketing (Shade, 2002). By the end of the 20th century, the television emerged as the electronic hearth. Here the family gathered, shared their day, and engaged in entertainment or debate (Tichi, 1991). Today Americans are spending less time in front of the television and more time in front of the new electronic hearth—the Internet. The average American spends close to three hours on the Internet per day, exceeding the number of hours spent watching television by 1.7 hours (Nie, Simpser, Stepaniknova, & Zheng, 2004).

The Internet has followed a diffusion of innovation pattern similar to all its predecessors, beginning as a communication tool for white, male scientists to share ideas, eventually being adopted by young male "inventor-heroes" who manipulated and improved it. These improvements motivated white businessmen to use the Internet to improve profits and productivity, gather information, and entertainment. In the end the computer, and as a result the Internet, left the man's world of work and entered the woman's domain of the home. Slowly, over the last ten years it has made a subtle impact on the lives of American women.

BACKGROUND

Over the first ten years of the Internet's life researchers have attempted to answer a number of questions about equity of access, gendered use of the Internet (both psychological and cognitive differences), and the impact of these answers on society. This article provides an overview of the community of Internet users and discusses these gender differences. The answers may help realize the goal of a genderless virtual world where all citizens participate equally regardless of age, race, creed, or gender.

Demographic Data

Although IBM first introduced personal computers for the home in 1981, they did not become commonplace until after 1994 when Netscape introduced their Internet browser, Mosaic. During the first six years of its commercial life the design and use of the Internet was dominated by men (Bimber, 2000; Ono & Zavodny, 2003). Since then women have slowly surpassed men to account for 51% of the Internet population (Pastore, 2000). In 2004, 64% of all homes in the United States had Internet access (Harwood & Rainie, 2004). However, there are still age and gender disparities among Internet users.

In 2004 access by age group showed the largest group of Internet users to be 35 to 54 year olds (45%), followed by 18 to 34 year olds (37%), with 55+ being the smallest group at 18% (Mediamark

Research, 2004). By January 2005, the 18 to 29 year olds had surpassed 30 to 49 year olds as the largest age group of Internet users (Pew Internet & American Life Project, 2005). There are virtually no gender differences in terms of the percentage of men and women using the Internet, until the senior population is analyzed. In 2003 the number of female seniors using the Internet reached 49%, up from 40% in 2000, but they still lagged behind senior males (Fox, 2003). One interesting gender difference deals with seniors who are *not* using the Internet. According to a survey conducted in 2002 of non-Internet users 61% of women vs. 49% of men said they would never use the Internet (Lenhart, 2003).

As for children, USC's Annenberg School found that 98% of online youth ages 12-15 used the Internet in 2003, up from 83% in 2000. This same study showed that 97% of online teens ages 16-18 used the Internet up from 91% in 2000 (Cole, Suman, Schramm, Lunn, & Aquino, 2004). A report published by the National Center for Education Statistics reported that 58.5% of children ages 5-17 used the Internet with no gender disparity (DeBell & Chapman, 2003). However, there are socioeconomic and access inequalities in Internet use. Those children living in households with higher family incomes and those with more highly educated parents were more likely to use computers and the Internet than those living in lower income households and with parents who were less well educated.

Internet Connectivity

While women's use of the Internet has reached parity with men there are still connectivity disparities concerning location (work, home, other), age of equipment, type of equipment, and connection speeds. A recent survey conducted by Mediamark Research indicated an equal percentage of men and women connect to the Internet only from work while a slightly higher percentage of women connect only from home, 51% women vs. 49% men (Mediamark Research, 2004). Another recent survey conducted by Pew in 2003 found that a gender gap existed between men and women who connected from other locations. Fifty-four percent of men vs. 46% of women connected from locations other than work or home (Harwood & Rainie, 2004). Men were more likely to connect from a friend's house while women were more likely to use a library. However, of those over 65, 90% of them connect from home compared to 10% from work (Fox, 2003).

When one compares age, location, and gender we see no remarkable connectivity gap between boys and girls (DeBell & Chapman, 2003; Jones & Madden, 2002). The most recent and comprehensive survey, conducted in 2001 by the National Center for Educational Statistics (NCES), shows that overall 78% of children ages 5-17 connect to the Internet from home compared to 68% who connect from school.

Aside from location, with home being the most convenient, the age of the equipment used to connect to the Internet is also important. Not surprisingly, women tend to have older and slower equipment. A 2001 survey by the U.S. Census Department found that on average women's computers were three years older then men's computers (U.S. Census Department, 2001). It also found that 44% of men owned a computer less than two years old vs. 37% of women.

Wireless, hand-held devices, like cellular telephones, PDAs, and pocket PCs are the next wave in information technology. These technologies are positioned to become an integral component of ubiquitous technology that provides instant access to information anytime from anywhere. Unfortunately, to date, they are disproportionately used by men with 65% men to 35% women (eMarketer, 2003).

The connectivity speed can often dictate the types of activities being conducted online. Multimedia presentations and images are large files that require a computer with enough memory capacity and the Internet connection bandwidth to view and download. Therefore, the online experience is better if the connection speed is faster and more robust. The latest connection type, broadband, is slowly overtaking the market accounting for 41% of Internet users. According to a 2003 survey by Nielsen/NetRatings, 52% of broadband subscribers are male compared to 48% female (eMarketer, 2003). This is good news for gender equity since the prevalent theory is that a quicker connection speed allows the user to explore the Internet for itself rather than for specific information.

Internet Use

How much time are men and women spending on the Internet? A 2001 National Geographic Survey (NGS) found that men spend 10.41 days/month finding information on the Internet while women spend 7.33 days/month (Kennedy, Wellman, & Klement, 2003). What are Internet users doing online? According to the 2004 Pew Internet & American Life project the most popular online activities conducted from home were:

- E-mail (45%)
- Getting news (27%)
- Checking the weather (20%)
- Looking for political information (13%)
- Instant messaging (12%)
- Watching video clips or listening to audio clips (11%)
- Online banking (9%)

Pew noted men are more likely to use the Internet to get news and sports scores while women are more likely to seek health and child care information (Fallows, 2004).

While e-mail is used by almost all Internet users, the Stanford Center for the Quantitative Study of Society found that women use e-mail and instant messaging for social purposes more than men, while men spend slightly more time browsing, checking out newsgroups and in chat rooms (Nie et al., 2004). Women spent 27.53 minutes per day using e-mail compared to 23.50 minutes each day for men. On the other hand, men spent 22.11 minutes per day browsing the Internet compared to women who spent 15.18 minutes per day (Nie et al., 2004).

Accessing news online is an activity more likely to be carried out by males than females. In 2004, 33% of men and 25% of women went online for news. When comparing education, age, and gender we see very different results. Approximately 74% of male college graduates under 40 regularly go online for news compared to just 45% of female college graduates (Pew Charitable Trust, 2004).

Although men and women are engaged in the same online activities, the way they interact with technology varies by gender. A 2000 National Geographic Survey (NGS) found that 60% of women compared to 54% of men felt that the Internet, specifically e-mail, brought them closer to their immediate and extended families. Meanwhile, the General Social Survey 2000 and 2002 (GSS) showed that women were using e-mail to maintain social networks while men were using it to maintain business relationships (Kennedy, Wellman, & Klement, 2003). Both NGS and GSS show three areas where men and women differ in Internet use: communication, information, and recreation. Women use the Internet to build communication networks while men use it to gather information and recreation.

Gender Differences

The diffusion of information technologies, like the computer, start with the early adopters who have traditionally been men. Over time they are adopted by women due in large part to economic necessity. This is because men have the social standing and means necessary to adopt new information technologies early. As these men interact with their friends, co-workers, and employees they provide the communication channel necessary to introduce the innovation to the early majority. Because women are usually not members of these two groups, early adopters or early majority, they fall under the late majority, coming to the innovation out of economic necessity; or they have no interaction with the innovation due to limited financial resources.

Despite gender parity in terms of percentage of Internet users and time online, women do not have similar experiences to men. Recent research has found that cognitively women and men interact with technology differently. Men process information visually, through the right side of the brain, while women process information textually, through the left side; therefore, men navigate the Internet more effectively with a mouse while women navigate best with hypertext links (Calvert, Mahler, Zehnder, Jenkins, & Lee, 2003; Rodgers & Harris, 2003). Low self-efficacy and anxiety are psychological issues that negatively impact a woman's experience with the Internet (Barron, 2004; Torkzadeh & Van Dyke, 2002; Zhang, 2004). As a result they are less confident in pursuing careers in programming and systems design (Lynn, Raphael, Olefsky, & Bachen, 2003). Women tend to be introverted, using the Internet to connect and find emotional support, while men are extroverted, using the Internet for stimulation either through gaming or pornography (Hamburger & Ben-Artzi, 2000). How the Internet is viewed also varies by gender. A 2002 study of children ages 11-16 showed that boys saw the Internet as a toy to be "tinkered" with and explored for itself while girls approached the Internet as a tool to complete tasks (Colley, 2003).

The best method of minimizing computer and Internet anxiety is to promote technology fluency through hands-on training (Broos, 2005). The more someone is familiar with a technological tool the higher their self-efficacy scores. Women, especially young girls, should begin creatively approaching the Internet through programming and design activities (Barron, 2004). These activities allow them to develop technological fluency and in turn minimize anxiety. Both boys and girls find the most effective teaching methods to be independent practice, friends, parents, and classes. Therefore instructors should create tutorials that address both male (visual) and female (textual) learning styles (Mumtaz, 2001). If young girls do not see the Internet as a toy to be deconstructed they run the risk of always having difficulties with emerging technologies (Torkzadeh & Van Dyke, 2002).

Internet video games are another tool that help young girls become computer literate, improve self-efficacy, and develop cognitive abilities like spatial orientation (Lynn et al., 2003). Further research by the organization Children Now found that 89% of the top selling computer video games contained either violence or subtle sexual content. Those games specifically designed for girls reinforce traditional gender stereotypes with characters like Barbie and Bratz (Glaubke, Miller, Parker, & Espejo, 2001). Game designers should develop games for girls that promote teamwork, transition with text, and avoid violence (Glaubke et al., 2001).

One way to keep adolescent girls interested in deconstructing technology is to show the connection between computers/Internet and traditional interests (Lynn et al., 2003). For example, interactive Web sites that utilize design software to create clothing, works of art, or animation teaches girls how to use complex technology, become motivated to use it, and find it relevant to the achievement of their goals. Once young women experience the power of the Internet they will want to become part of its future. This is also the point where women who are in technology professions need to consider becoming role models and mentors to aspiring female innovators (American Association of University Women, 1999).

FUTURE TRENDS

The future Internet will most likely not resemble the current Internet. As ubiquitous technology enters mainstream society, information will become accessible anytime, anywhere, and through a multitude of devices. Our stoves will connect us to recipes; our refrigerators will e-mail the local grocery store to hold milk and eggs for pickup; and televisions, the old electronic hearth, will be replaced by multimedia centers complete with Internet access to the latest movies, music, and online college courses. Streaming video will become an Internet staple due to high-speed broadband or other, faster connections. Textual blogs will give way to video blogs and everyone will have their fifteen minutes of fame. Eventually the lines between work and home will blur further and leisure time will include the Internet as an activity.

Will women play a major role in the development and use of emerging Internet technologies? A larger number of women will need to enter computer science professions in order to become the innovators and early adopters of emerging technologies. Teachers will need to adapt teaching styles and employ problem-solving skills familiar to young girls. The media will need to move away from the stereotype of computer expert as nerdy, lonely boy/man. Finally, parents will need to engage their daughters with science and technology that is of a gender-neutral nature. In combination all of these factors will help young women become comfortable with the hardware and software used to create emerging technologies.

CONCLUSION

The Internet has helped women expedite tasks that would have taken them away from family, careers, and leisure time. Now they can order dinner, bank online, grocery shop, download do-it-yourself tutorials, and apply for a mortgage from the comfort of their homes while doing traditional tasks like childrearing and housework, things women will always do.

With the numbers of young women online fairly consistent with the numbers of young men, it could be said that the gender gap has been closed. But has it really? Women continue to trail behind men in computer related courses and careers and gender related privileges are still being replicated on the Internet through things like pornography, male oriented terminology and cyber harassment (Gorski, 2003; Spender, 1996). Family, educators, the government, and the media need to encourage young women to enter into technological fields of study and designers must begin creating either female friendly or gender-neutral hardware and software. It is through these measures that the next generation of women will feel comfortable and confident enough to become the next great technology innovators.

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KEY TERMS

Bandwidth: The information carrying capacity of a network or connection to the Internet.

Blog: (weB LOG) A personal, interactive journal that is available on the Web.

Cyber: Prefix to words used to indicate an association to the Internet or virtual world.

Cyber Harassment: Threatening behavior towards someone using the Internet.

Diffusion of Information Technologies: Based on Everett Rogers' *diffusion of innovation* theory that innovation is communicated through certain channels over time among the members of a social system.

Digital Divide: Term used to refer to the gap between those who have access to technology and those who do not.

Gender Gap: Unequal treatment or access to a product or service due to a person's gender.

Hand-Held Devices: Hardware used to access the Internet wirelessly such as personal digital assistants (PDAs), cell phones, and MP3 players.

Ubiquitous Technology: Information is delivered anytime, anyplace, anyway. Futurists see an Internet that is embedded into appliances, consoles, clothing, watches, cars, etc. that can be used to access information, complete a task, or entertain. Eventually information technology is seamlessly woven into our daily lives to the point that going online is a continuous state of being.

Gender and the Use of DSS in the Australian Cotton Industry

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INTRODUCTION

This article provides an overview of an ongoing study that explores farm management practices by Australian women cotton growers using farm management software, most particularly agricultural decision support systems (DSS). The research methodology is interpretive with multiple case studies of women cotton growers and industry professionals. Participants were selected on the basis of indicating an awareness of environmentally responsible and high technology farming practices. Data collection was principally by semi-structured in-depth interviews. The study is informed through a theoretical framework of structuration theory as a metatheory for probing the recursiveness of farm management and technology usage, and diffusion of innovations theory as a lower-level theory for analysing the characteristics of the software.

Evidence from the study suggests that farm women intentionally select specific software modules for implementation depending on the attributes of the software. Further, while computer-based farm management systems, including agricultural DSS, are recognised media for technology transfer of industry research to farms, the study found the cooperation of farming partners to be essential in influencing effective reconstruction of farm management practices and software usage. The study also explores gender homophily, in particular the relationship between husband and wife as partners in a cotton farm business. It is apparent that gender differences and inequalities are still prevalent and indicative of "gender heterophily." Nevertheless, in the main, communication between parties is harmonious, empathetic, and by definition homophilous, thus ensuring effective information exchange.

A notable benefit of using decision support software is an enhanced critical awareness of existing farm management practices. Further, the women are empowered by increasing confidence to contribute in enterprising ways to a greater range of farm management tasks and to more innovative applications of computer-based farm management tools.

BACKGROUND

The cotton industry in Australia is thriving. Nevertheless, cotton management is becoming increasingly complex with the need to sustain reliable crop production while making the best use of water and soil resources, to utilise effective pest and weed management, as well as to limit environmental impacts (The Australian Cottongrower, 2004). Innovative technologies, such as the agricultural DSS, *CottonLOGIC,* are considered keys to the adoption of sustainable farming systems (Hearn & Bange, 2002).

While the literature is sparse in the specific research domain of my study, there has been extensive research in categories such as DSS and farm management, and gender and information technology (IT). Although the portrayal of women in farming has been the subject of many studies both in Australia and overseas, the range is more limited when the study includes the use of computers. One study of rural women embracing computer usage was by Stewart (1997). For her PhD, she explored the gendering of interactive communication technologies (ICTs) in use on Australian family cotton farms. Stewart found that farm women's lack of confidence as controllers of data meant that they often avoided responsibility for utilising computer-based information systems for decision making purposes. Even so, Stewart found evidence that many rural women were increasingly aware of the possibilities of computers for decision making, encompassing new and innovative farm management practices.

In her research into the lives of Australian farm women, Alston (1995) argues that farm roles have developed based on gender stereotypes and that traditional divisions of labour prevail. Male farmers are participants in the "more important" public sphere of outdoor work while farm women have become associated with the less visible private sphere of housework and children. This "domestic work has come to be devalued because it is unpaid and not directly geared to agricultural production and the marketplace" (Alston, 1995, p. 24). The theme of the "invisibility" of women farmers emanated from research by Sachs (1983) and has resonated through feminist studies of Australian rural women. Further, James (1989) claims that despite the increase of legal farm partnerships, the participation of women in decision making on the Australian family farm is unclear. Moreover, there is evidence that divisions of responsibility in farm management, largely based on gender, may actually contribute to poor decision making (Daniels & Woods, 1997).

The value of women's work has engaged sociologists beyond the farm gate. Sharpe (1992) in a reader on human societies edited by Anthony Giddens, discusses the difference between paid work outside the home and unpaid domestic work in a British urban setting. She argues that women's self-esteem may become bound up with the care and services provided to family members, and notes that "this unrecognized work is in effect the service and maintenance of the workers of today and tomorrow. It *is* related to the external world of production, but indirectly" (Sharpe, 1992, p. 56).

DISCUSSION

The following section outlines preliminary findings from the study in three papers written by the author (Gartshore, 2003; Gartshore, 2004; Mackrell, 2005).

Software Attributes and their Relevance

In analysing the use of an innovation such as *CottonLOGIC*, Gartshore (2003) utilises the concepts of divisibility (or modularity) and implementation costs, in particular, intellectual outlay from the environmental model of technology diffusion (Vanclay & Lawrence, 1995). While *CottonLOGIC* is a software package that consists of several modules, for the most part, the women cotton growers deliberately selected modules pertaining to the recording of field and spray operations. These modules enabled them to record the usage of fertilisers, herbicides, pesticides, and so on. This meant that the women were better informed particularly for managing costs of production and improving sustainability. These modules were also envisaged as useful by one of the women cotton consultants whose aim is to provide a more complete record of clients' farming operations.

As elaborated further in the paper (Gartshore, 2003), intellectual outlay takes into account, (1) complexity of the innovation, (2) collaboration by stakeholders, (3) redundancy of effort, and (4) *CottonLOGIC* course participation. Participants in the study acknowledged the varying intellectual expense in the implementation of *CottonLOGIC*. While the *CottonLOGIC* training courses were greatly appreciated, and went a long way to addressing the computer deficiencies of users and the agronomic complexity of the software, the individualistic needs of the women meant that there often remained a mismatch between the skills required to operate the software and the skills possessed by many cotton growers. Further, the notion of redundancy appeared important as an influential factor in the adoption or non-adoption of *CottonLOGIC*. Many participants clearly stated their objections to re-keying the insect count data for the insect prediction models that had been previously entered into *CottonLOGIC* by crop scouts or cotton consultants. As well, communication with partners and agronomists was deemed desirable in achieving optimum results.

The following extract from an interview with Selma, a cotton grower, supports and illustrates the generally harmonious and productive rapport reiterated by women cotton growers. It highlights the importance of collaboration and cooperation in a family farm setting, with few inklings of "invisibility" and of being undervalued.

We work as a team really. I'm more focussed on the administration side of things. X [farm partner] is more focussed on the day-to-day running, and *keeping out of the office which he shouldn't do. He needs to be more involved.*

Overall, the farm women interviewed demonstrated a high level of confidence in their ability to use computer-based farm management systems and a critical recognition of the software's functions. Furthermore, it appeared that the use of *CottonLOGIC* by farm women was instrumental in augmenting their level of awareness, understanding, and interpretation, thus provided them with additional confidence to challenge existing practices. This was exemplified in a statement by a Diane, a manager of a cotton service business:

If women can do CottonLOGIC…they also have a far better exact knowledge of what's happening on the farm so therefore are far better equipped to have a very equal involvement in decision-making whereas a lot of decision-making happens in the garage [shed] …

Vanclay et al. (1995) studied the crises in Australian agriculture, especially the issue of environmental degradation during the 1990s, from a critical rural sociological approach. They analysed the various theoretical perspectives in use in rural extension including the technology transfer model, premised on diffusion of innovations theory (Rogers, 1983, 1995, 2003). In attempting to examine aspects of the diffusion process, Vanclay et al. considered factors affecting the non-adoption of technology including divisibility and implementation costs. Their research found that current thinking is inadequate in addressing existing environmental problems. In particular, the author drew from their work the differentiation between technological innovations of a commercial nature and those more environmentally focussed.

Technology Transfer from Researcher to Farmer

Building on the concept of communication, applicable to both structuration and diffusion theory, Gartshore (2004) investigates the communication process for informing cotton growers of the latest science available from research. Informing science can transpire through social and technological communication channels. Even though the focal point of the study is the agricultural DSS, *CottonLOGIC*, the cotton industry engages other channels of communication such as verbal, fax, Web, electronic and standard mail. Filtering of vital information demonstrates cooperation by the farm partner who spends time in the farm office rather than in the fields and provides opportunities to translate new knowledge from scientific research into changing practices for both farm management and technology usage. Thus cotton growers are better informed particularly for managing costs of production and improved sustainability. As Renee, a cotton grower, intimated:

I'm informed and if I relay it back to him [farm partner], it's both of us knowing what's going on.

One of the initial influences for the author in pursuing the technology transfer aspect of agricultural DSS was studies by Cox (1996), a rural researcher working in country Australia. While some of the findings by Cox had aroused intense controversy and debate at the time, the author was particularly interested in his work on communication, most specifically the use of DSS where he states that "the criteria for success…should relate to the critical insights gained through improved communication of the different perspectives of researcher and farmer" (p. 376).

Social Networks and Teamwork

Mackrell (2005) examines gender homophily in interpersonal networks within the context of Australian family cotton farms. While traditional gender divisions of labour exist for whatever reasons on the family farm, at a professional level within the industry, gender distinctions are less apparent. This confirms past research (Powell & Johnson, 1995) that associates formal training, as for agronomists and industry service personnel, with improving women's confidence as independent decision makers and managers. This also endorses the social constructivist perspective that gender is a socially constructed concept rather than biologically determined.

The paper by Mackrell (2005) validates previous research that suggests that communication networks in organisations are largely clustered by gender and that same gender networks are associated with effective communication (Brass, 1985). It is apparent from the study by the author that while informal all-male networks are a valuable media for knowledge exchange for the men, the women have to strive harder to overcome occasional hostile reactions before establishing more formal social contacts such as *WinCott* (Women's Industry Network Cotton). The author argues that while gender homophily exists within the single sex networks, it would be more accurately described as "gender heterophily" between the all-male and all-female networks.

In the setting of the cotton farm, despite the existence of "gender heterophily" through disparate gender relations as in the traditional gender divisions of labour, a more compromising and harmonious atmosphere prevails to facilitate effective communication. This confirms research that a certain degree of heterophilous communication might be the basis of positive "creative dissidence" or synergy between the interacting parties (Sumberg, Okali & Reece, 2003, p.744) and that "heterophilous individuals who have high empathy are, in a psychologist sense, really homophilous" (Rogers & Shoemaker, 1971, p.14).

Homophilous communication is crucial for effectively transmitting knowledge about the features of *CottonLOGIC* as well as its novel possibilities for improved self reliant farm management, the value of which is encapsulated in a statement by George, an independent cotton researcher:

DSS [such as CottonLOGIC] have the potential to put the management of diseases back into the hands of the people who live there, so far it's mainly the male partners, the man. But increasingly both, if they are given this sort of technology [CottonLOGIC] where they can put all these specialist things into context, by that simple process, they take the excess power away from the expert and back into their own hands where it belongs. And they have the ability through technology to weigh options.

As previously mentioned, Stewart (1997) in her PhD study, explored the use of ICTs by farmers on Australian family cotton farms. Her research, informed by the conceptual framework of Connell's theory of the social construction of gender, identified gendered structures of labour and power. She found that women were constrained in the use of technology by the acceptance of dominant ideal constructs of masculinity and femininity. In her conclusion, she foresees:

The greater take-up rate of computers by farm women than by their husbands suggests on the face of things that some women at least are being assisted by ICTs to develop more equal partnerships with their husbands and members of their extended farming families than were possible in the past ... (p. 342)

However Stewart warns this may be only temporary and may change as farm men become more computer literate. Mackrell (2005) has not identified this tendency.

FUTURE TRENDS

Future trends are offered from both practical and theoretical perspectives. There is considerable current debate amongst stakeholders such as farmers, scientists, researchers, DSS developers, and government as to the future direction of *CottonLOGIC* (Hearn et al., 2002, p. 49). Should the DSS development team concentrate limited future resources on the record-keeping modules or the prediction modules for decision support, or both? Indeed, findings from the study have already contributed to a business plan commissioned by the CRDC in 2004.

The contribution to theory may also have significance. The use of sociological theories to explore gendered concepts has proved to be a challenge since neither diffusion theory (Rogers, 1983, 1995, 2003) nor structuration theory (Giddens, 1984) explicitly address gender relations and matters of patriarchy. Although both theories overall provide a rich framework with which to inform the topic, the concept of gender is too important to ignore and is a notable omission, especially from diffusion theory.

In addition, Australian feminist rural researchers, Pini and Previte (2004) provide inspiration to address the methodological and epistemological aspects of the study with their view:

... feminist research is not simply research on women or gender, but research on women or gender which acknowledges and seeks to address gendered injustice. Feminists are concerned, not with simply obtaining knowledge, but on the process by which knowledge is collected and the way in which knowledge is used (p. 2).

CONCLUSION

The cotton industry endorses the use of innovative technologies such as agricultural DSS to enhance sustainable farming systems. This study in seeking to better understand the constructs associated with the adoption and implementation of *CottonLOGIC* by rural women, has the potential to generate improved resource management on family cotton farms with flow-on benefits to the Australian rural sector.

Evidence from the study reinforces the existence of gender differences and inequalities in rural Australia. Nevertheless the environment is dynamic, with transformations in social structures occurring. Women are taking the future into their own hands. With confidence gained through involvement in interpersonal networks, participation in training, and the acquisition of technological skills, they are shaping and reshaping their lives. In particular, computer-based software such as *CottonLOGIC* is instrumental in enabling them to challenge and influence the reconstruction of existing farm management practices and technology usage. This reflects a central principle of structuration theory concerning the recursiveness of social life.

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KEY TERMS

CottonLOGIC: *CottonLOGIC* is a software package of decision support modules for assisting cotton growers and their advisors in the tactical management of cotton pests, soil nutrition, and farming operations. It enables the recording and reporting of insect populations, weather data, crop yields and field operations such as fertiliser, herbicide and pesticide applications, as well as the running of prediction models to forecast pest density and soil nutrition. It is being developed in Australia as an advanced farm management tool by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Cotton Cooperative Research Centre (CRC), with support from the Cotton Research and Development Corporation (CRDC).

CRDC: The Cotton Research and Development Corporation is a partnership between the Australian Government and the Australian cotton industry to provide leadership and investment in research, innovation, knowledge creation, and its transfer.

DSS: While there is no universally accepted definition, decision support systems may be identified as interactive computer-based systems that support decision makers.

Farm Management: Factors include decision making, production, marketing, human resources, financial, risk and change management.

Gender Homophily: Recent research has identified homophily in a variety of characteristics such as gender, age, class, race, and occupation, and in a range of social settings such as organisations, cultural communities, and families (McPherson, Smith-Lovin, & Cook, 2001). However there is no evidence of previous use of the term "gender heterophily."

Heterophily: Heterophily, the mirror opposite of homophily, is the degree to which pairs of individuals who interact are different in certain attributes (Rogers, 1983, 1995, 2003).

Homophily: Homophily, the tendency of people in friendship pairs to be similar, was recognised before the 1900s (Rogers, 1983, 1995, 2003).

Information and Communication Technology: This refers to the range of technologies that facilitate communication. They include telephones, mobile phones, fax machines, and personal computers which may or may not be connected to the Internet.

Technology Transfer: This principle of science-based intervention, also termed the "transfer of technology" push, has been criticised for ignoring the socio-economic context.

WinCott: The Women's Industry Network Cotton was formed in 2000 to provide support, information and resources to encourage and empower women in the Australian cotton industry to have skills, confidence and an informed voice.

Gender Bias in Computer Courses in Australia

G

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INTRODUCTION

The participation of women in science and, more recently, in information technology (IT) has engaged researchers for more than 20 years. Despite extensive research and numerous practical interventions designed to address the relative dearth of women in IT, the problem persists. This is an important question since computing and computer competence are critical to ongoing developments of the "information revolution." Evidence from around the world suggests that despite female predominance in undergraduate enrolments (59% in Australia, 55% in America, and greater than 50% in many European Union countries), women are reluctant to pursue IT study at tertiary level (Rees, 2001).

Initial approaches to reverse this trend centered upon notions of equality and affirmative action, since the lack of significant numbers of females in the discipline was seen as inequitable. To alleviate the problem, intervention programs aimed at women have promoted information on technology-related careers, provided experience of computing work, and highlighted female role models. Other initiatives focused on helping women develop skills, attitudes, or background knowledge that women were thought to lack. These affirmative action measures, while commendable in fostering gender equality, were not sufficient in that they often served to reinforce the conceptions of IT as a masculine domain and, consequently, failed to attract women to IT. This suggests a need for an alternative approach—a reconceptualization of IT into an environment that women would naturally embrace. Such a need, in the area of tertiary computing education, motivated this study.

The aim of the study was to investigate, from the students' perspective, the perceived problems faced by female computing students at Victoria University in Melbourne, Australia; the study focused on problems related to the learning environment, particularly on direct and subtle gender-related problems encountered in the classroom, and special needs of female students.

BACKGROUND

Gender-Related Issues in IT Education

The underrepresentation and poor retention of female students in IT courses, including computer science, both in Australia and elsewhere, has been well recognized. The already low number of female students enrolling in computer science is usually further decimated by high attrition rates. This situation has often been attributed to gender differences in interests, motivation, experience, personality characteristics, abilities, self-efficacy, and socialization. These differences, which put females at a disadvantage in computing courses, stem from a variety of factors both external and internal to the institution offering the course. External factors include: the popular perception of the male-dominated computing culture, its particularly masculine character and, often, a "geek" image. The internal factors include: inadequate pedagogical techniques, stereotypical attitudes of lecturers and fellow students, and lack of proper institutional support (Fisher, 2003; Miliszewska & Horwood, 2002; Newmarch, Taylor-Steele, & Cumston, 2000; Nielsen, von Hellens, & Wong, 2001).

While external factors lower female students' self-confidence in their computing skills, abilities and accomplishments even prior to entering the course (Lazowska, 2002; Zeldin & Pajares, 2000), internal factors are likely to deepen existing negative impressions even further, and create new ones through:

- **Negative Classroom Experiences:** caused by assumptions of prior knowledge and hands-on experience with computers, stereotypical attitudes and interaction style (often patronising or aggressive) of lecturers, and fellow students

(Lazowska, 2002); lack of structured environment and detailed instructions (Crump, 2001); and, unwanted positive discrimination—in the form of easier assessment for instance (Nielsen, von Hellens, & Wong, 2001)

- **Inadequate Access to Computers in the Classroom:** often dependent on the level of aggressiveness of fellow students (Clayton & Lynch, 2002; Davies, Klawe, Ng, Nyhus, & Sullivan, 2000)
- **Unequal Participation in Class:** females are not: allocated equal time on computers, called on equally in class, assigned equally difficult tasks, or participate in the interaction between lecturer and students as often as males (Levenson, 1999)
- **Lack of Interesting Gender-Neutral Projects in the Course:** the course includes few goal-oriented tasks on which females could work in teams (Weinman & Haag, 1999); lack of problems and examples from diverse disciplines outside of computer science (Blank & Kumar, 2002; Cohoon, 2002)
- **Lack of Role Models and Career Advice:** few female lecturers and tutors, few female fellow students, "invisible" successful career women, stereotypical career impressions and a lack of information about computing as a career (Cohoon, 2001; Crombie, Abarbanel, & Anderson, 2001; Teague, 2002)
- **Inadequate Institutional Support:** lack of special programs that would enable females to learn computer basics and computer jargon, and help them feel comfortable around computers; lack of encouragement and mentoring on the part of the lecturers; lack of institutional support in gender-sensitive teaching (Crump, 2001; Cohoon, 2001)
- **Lack of Peer Support Groups:** lack of interaction between, and lack of support networks among, students in class (Springer, Stanne, & Donovan, 1999).

Despite the existing body of research, there is no consensus on the gender disparity in computer science and, while the reasons why females desert computer science are still unclear, female representation in the discipline continues to decline.

Gender and IT at Victoria University in Melbourne, Victoria

Participation and retention of females in computer science at Victoria University is a particularly elusive issue. Computer science appears to offer an attractive scenario to potential female students—gender-neutral curriculum, attractive career path, and high salary scale. Why then, are the trends in the opposite direction? Despite a range of initiatives created to encourage participation and improve retention of females in the computer science course, female enrolments have declined significantly in the recent years (from 31% in 1994 to 18% in 2004), and attrition rates soared (from 18% in 2000 to 40% in 2003—in the first year of the course alone).

Since various initiatives undertaken over the years failed to impact on these disappointing trends, the underlying problems appeared to reside elsewhere and new research was needed to guide retention efforts. It was decided to conduct a study that would focus on internal factors, particularly the classroom environment: of interest was the possibility of gender bias in the learning environment and its impact on female attrition rates.

Gender and IT: Student Perceptions

The objective of the study was to investigate issues pertinent to the pedagogy and content of computer science courses, as well as the classroom climate, with a goal to make the discipline more inclusive for female students. A multidisciplinary research team was formed in mid 2003 and funding for the study was secured from the government-sponsored Higher Education Equity Program (HEEP).

Four focus groups consisting of two single gender groups and two mixed gender groups were conducted: 32 students representing both genders and all year levels participated. The central topic of the focus groups was gender equity in the computing learning environment; the key question: "Why do female students drop out of the course?" The comments made by students during focus groups centered around issues of gender balance of both students and teachers, course content, resource access and collaborative activities:

- **Gender Balance:** The fact that the majority of students in the computing course were male was of little concern to either male or female students. Similarly, students did not regard the gender of the lecturers as important—competence and good teaching skills mattered. However, female students perceived female lecturers as more friendly and approachable
- **Course Content and Resource Access:** Attitudes to the content of the course were more ambivalent. Although all students felt that the course content was determined by its technical nature, there was some acknowledgment that more alternative "female-friendly" practical course material might have been chosen. However, both female and male students considered that they had equal access to computers in the computer laboratories and that there was no evidence of male dominance or "bullying" in claiming available machines. The suggestion, reported in research literature, that male students tend to "hog" computers and exclude female students was met by all students with utter disbelief
- **Collaborative Activities:** With respect to group work, the only interest that potential group members had in each other was their competence and willingness to work—gender seemed immaterial. Interestingly, all students testified to a truly collaborative approach to group work with the work being shared and rotated within the group to ensure that all members, female and male, gained experience of the differing demands of the project. The recognition of the skills that each member brought to a group project was clearly evident.
- **Further Reasons for High Attrition of Females:** Lack of self-confidence and lack of friendships were considered major factors, as was the overall difficulty of the course, particularly programming subjects; lack of interest in the course from the beginning and family concerns were also perceived as a contributing factor. Female students expressed the need for more support, especially of a social nature. They also perceived a need for students to be better prepared for the university experience

Following the analysis of focus group findings, a survey was developed to seek confirmation of these findings from a wider cohort of computing students and discover other factors contributing to growing female attrition rates. Two hundred and ten students completed the survey: 47 females, and 163 males. The respondents were young: the median age for females was 23, and for males 21 years; they came from all year levels of the course; and, they typified the students in the course, and indeed the University, with respect to their ethnic origin and educational background. Almost 70% of respondents were born overseas, and nearly 56% of respondents spoke only a language other than English at home. Although the majority of students entered the computing course directly after completing high school, 28% of males, and 38% of females entered the course after completing other types of further training.

The survey responses addressed the following issues:

- **Transition to the Course:** Although a greater percentage of female students found coping with study load, finding friends, and balancing study with family and work commitments difficult, the differences were not significant in comparison with male students. Another important transition issue was that of adjustment duration. A majority of all students (78% of females and 84% of males) settled into the course within the first six months. However, male students adjusted much more quickly; nearly 60% of male students took less than two months to settle, as opposed to only 38% of females in the same time period
- **Satisfaction with the Course:** The level of satisfaction/dissatisfaction with several aspects of the course was the same for both genders. However, there were differences with satisfaction with course content. Views were more polarized among female students. A greater percentage of females than males found it satisfactory (43% vs. 31%) but at the same time, more females than males found it unsatisfactory (21% vs. 15%). Significant difference between the genders occurred only

with satisfaction about own performance; male students were more satisfied with own performance than their female counterparts

- **Intention to Quit the Course:** While one-half of the students (53% of females and 48% of males) never considered quitting, the other half thought about it—17% of both females and males alike thought about it seriously. Among various factors that influenced their decision to continue in the course, family encouragement rated highest, especially among male students. No correlation was found between the students' intentions to quit the course and either their educational or ethnic backgrounds. However, a comparison between the intention to quit and the students' current year of study revealed that the intention was strongest among females in their second year of study–nearly 60% of them considered quitting
- **The Issue of Gender in the Course:** More than half of the students of either gender did not regard the underrepresentation of females in the course as a problem; interestingly, fewer females than males (17% vs. 28%) felt that underrepresentation of females in the course was a problem. However, female students tended to agree more that male students "hogged" computers in laboratories; they also preferred not to work with other students, particularly male
- **The Content of the Curriculum:** All students considered the curriculum largely gender neutral and the distribution of agreement was similar for male and female students. Both groups were equally comfortable with voicing their opinions in class and felt that those opinions were received positively. Neither group felt that an equal gender representation in the course was needed to improve their willingness to speak in class
- **Seeking Help:** For females, the most preferred source of academic help was their fellow female students followed closely by female lecturers; male tutors came last. For males, fellow male students were the first choice, followed by male lecturers with female tutors in the last position. When seeking help on personal problems, female students would again firstly turn to their fellow female students. The next three choices of female lecturer, female tutor, and fellow male student were far behind the first choice; male tutor was the least preferred option. Male students, too, nominated their fellow male students as, by far, the most preferred source of help on personal problems; female tutor was the least preferred choice.

FUTURE TRENDS

The overall findings from the study were rather surprising, as they yielded no strong indication of gender bias in the learning environment of the computing course. The focus group moderator emerged from the focus group sessions somewhat baffled having expected answers that would support the original hypothesis of the research study—that the existence of gender bias in the learning environment contributes to high attrition rates of females in computing courses. That thesis was not sufficiently supported. The focus group moderator concluded *the students are telling me that there is no entrenched overall problem: you are doing a good job*. It was a bittersweet conclusion: sweet was the knowledge that the students, both male and female, found their learning environment gender-neutral; bitter was the realization that if gender bias did not drive females away from the computing course, then something else did.

The fact that over one third of female students entered the computing course after completing further postsecondary training, may suggest that this type of training is a good preparation for computer science for females. Conversely, significantly more males than females came to the course straight after high school. This may be a vital clue to the problem of underrepresentation of females in the computing course. It may suggest that the course either does not appeal to high school females, or that the information about the course does not reach them in the first place.

The first year, particularly the first semester, of the course emerged as the 'make or break' period especially for female students. Not only was it an important period with respect to adjustment to the course, but also it was a period most likely to influence most female students' decisions about quitting the course. It appears that staff encouragement mattered little in dissuading female students from quitting, but the support of fellow students was important. Male students highlighted family encouragement to continue with the course significantly more often than females did. Is this a sign of gender bias within the family?

While the lack of female role models in the course was not identified as important, the preference for seeking help from female as opposed to male staff members seems to suggest to the contrary. Is it gender stereotyping, or are female staff members more available to help?

CONCLUSION

This article reports on the findings of a study conducted at Victoria University in Melbourne, Australia, that explored the relationship between gender bias in computing courses and attrition rates of female students from these courses. Since gender characteristics, such as role stereotyping, mathematical ability, interest, and attitudes towards computers were not sufficient to explain the increasing loss of females from computing, it appeared that characteristics related to the IT environment might exaggerate gender differences. Hence, this study was directed at environmental conditions within the control of the University including course curriculum, pedagogical techniques, access to computers in the classroom, class participation, and institutional support.

The findings obtained from focus groups with students yielded some unexpected results. The responses of the students were surprising in terms of their overall assessment of the computer science course, especially against the background of diminishing female numbers. The overwhelming message delivered by all students was that there were no major gender-related problems in their learning environment.

The results of a subsequent survey confirmed most of the focus groups findings. However, some of the survey results contradicted the findings of the focus groups, for instance: equal access to computers in laboratories, and problem-free group-work. Moreover, although female students did not regard the underrepresentation of females in the course as a problem, they singled out their fellow female students as the vital source of both academic and personal help, thereby reiterating the need for female peers in the course.

Transition to the course was identified as a possible factor contributing to high attrition rates of females in computing courses. Not only did the female students take considerably longer to settle into the course, but they also were most likely to drop out of the course after the first year of study. The large number of students contemplating dropping out of the course is a concern, as is the largely insignificant role of staff in persuading those students to stay.

While this study has provided some explanation of the high attrition of females in computing courses, the challenge still remains to develop strategies to minimize it.

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KEY TERMS

Attrition Rate: A measure of the proportion of students who fail to complete a course of study.

Further Training: Post-compulsory education and training, excluding degree and higher-level programs delivered by higher education institutions, which provides people with occupational or work-related knowledge and skills.

Gender Bias: The tendency to give greater attention to one gender over the other, whereby such favoritism is based on prejudice, stereotyping, distortion, and irrational preference.

Participation Rate: The percentage of all students (commencing and continuing) in a particular course of study.

Retention Rate: A measure of the proportion of students who re-enroll in a subsequent year (of those who have not completed).

Transition: A period of significant adjustment, development, and change affecting all spheres of students' lives.

Underrepresentation: Participation of less than 40% (according to the higher education definition).

Gender Differences in Adolescents' Attitudes about IT Careers

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INTRODUCTION

Adolescents are the fastest growing segment of computer and Internet users, reporting heavier use than their parents (Lenhart, Madden & Hitlin, 2005). Though the popularity of technology continues to flourish and drive the American economy, recent studies suggest that the revolution may be leaving females behind at later ages (Cooper & Weaver, 2003; McDonald, 2004). Employment data from the United States (U.S.) Bureau of Labor Statistics show that the U.S. high-tech computer industry employs nearly 5 million workers, making it one of the nation's largest and most lucrative industries. Yet the number of women earning computer science degrees in the U.S. has plummeted over the past two decades, causing women to be vastly underrepresented in the information technology (IT) workforce (McDonald, 2004; National Science Foundation, 2004).

BACKGROUND

After high school, the majority of young women make academic choices that steer them away from IT careers (Stabiner, 2003). Early gender differences in computer attitudes may be a precursor for later academic choices. Guided by Eccles and colleagues' (1998) expectancy-value model of achievement motivation, this article provides an analysis of gender differences in adolescents' attitudes about IT careers. The expectancy-value model of achievement motivation suggests that adolescents' expectations for success and interests predict career plans. Findings from past empirical research in the domains of mathematics and science corroborate this model and suggest that individuals base their educational and career plans on expectations for success and value/interest (Eccles, Wigfield, & Schiefele, 1998).

Expectations for Success in IT Careers

Although female college freshmen have significantly closed the gender gap in computer use, there are still overwhelming gender differences in adolescents' expectations for success in the IT domain (Dickhauser & Stiensmeier-Pelster, 2002). The gender gap in computer-related ability beliefs first appears in the elementary school years and widens as students move through high school, into college and beyond. By the time adolescents graduate from high school, the gender gap in computer attitudes is striking, with males reporting more positive attitudes toward computer technology than females (Kirkpatrick & Cuban, 2000).

While the gender gap in computer confidence has always favored males, the gap among the 2000 college freshman class was actually the largest in the history of the University of California—Los Angeles' (UCLA) ongoing survey of students. First-year college women and men reported almost equal computer use, but female freshmen were only half as likely as men to rate their computer skills highly (Sax, Astin, Korn, & Mahoney, 2000). Females are also more likely to consider themselves "not the type to do well with computers," and less likely to say they "could handle a more difficult computer course" (Young, 2000). This gap in self-confidence may contribute to the fact that men are significantly more likely than women to pursue careers in computer programming.

Interest in IT Careers

In addition to expecting less success with computers, girls also report less favorable computer value and interest, especially during adolescence. Most studies report minimal gender gaps in computer attitudes during elementary school; however, by the time students graduate high school, the gender gap in computer attitudes is significantly larger, with males revealing more interest in technology, even when computer experience is controlled (Kadijevich, 2000; Kirkpatrick & Cuban, 2000). Male students are also more likely than female students to enroll in high school computer classes, perhaps indicating higher levels of interest for boys than girls (AAUW Educational Foundation, 1998; Bleeker, 2005).

As females reach adolescence, they often begin to attach their career interests to people-oriented social contexts and become most interested in jobs that will allow them to make a difference in society (Eccles et al., 1998; Margolis & Fisher, 2003). Not surprisingly, most young women who choose to major in computer science typically enter the field because of applied purposes, rather than a passion for programming or technology (Stabiner, 2003). Unfortunately, young girls often fail to see the high-tech industry as a key to helping others or making a contribution to society.

Moreover, many adolescents choose to pursue occupations other than those in technology because they are unable to relate their everyday interests in computers to IT careers (see Dryburgh, 2000). Lack of interest in pursuing computer science degrees may be related to stereotypical perceptions of computer scientists (McDonald, 2004). Even though some adolescents spend more than 16 hours each week in front of a computer (Bleeker, 2005), many express negative views about programming work and have a general aversion to the field of computer science. Computing careers are often perceived as involving little human contact, consisting mostly of keyboard work and lacking in creativity. These job characteristics seem to be especially unattractive to girls (Gilbert, 2002).

CURRENT STUDY

Much past research has failed to look closely at adolescents' perceptions of *different types* of careers within the broad field of IT. Based on past work (see Eccles et al., 1998) showing the importance of girls' valuing of "people-society job" characteristics, it seems likely that females may value certain IT careers (Web development, technology assistance) more than others (programming). Most past studies (e.g., Kadijevich, 2000), however, have asked adolescents to report attitudes only about computer science careers, or have simply asked adolescents to estimate how often they might use computers in their future careers. This article moves beyond these limitations and attains a more complete picture of adolescents' levels of interest and efficacy for IT careers. By assessing adolescents' attitudes about various IT careers rather than simply asking about computer science, this study investigates possible gender-based trends in attitudes within the broad IT workforce.

During the fall semester of 2004, 460 student participants (213 girls, 247 boys) were recruited from two public high schools (grades 9-12) in the northeastern U.S. At both high schools, an identical Web-based survey was administered to students during class time in a computer lab. The majority of students enrolled in the high schools were European-American and from middle- to lower-middle-class households (National Center for Education Statistics, 2004; U.S. Census Bureau, 2000).

Adolescent participants were asked to answer questions about seven different IT jobs, indicating their *expectations for success* and *level of interest* in the occupation. The list of seven jobs was created using the IT occupations listed on the U.S. Department of Labor's computer science Web page (Bureau of Labor Statistics, 2003; see Table 1). To help participants assess their beliefs about each occupation, a short description of each job was included, based on descriptions provided by the U.S. Department of Labor (Bureau of Labor Statistics, 2003). Items were answered using seven-point response scales, ranging from "not very" to "very." Thus, higher scores represent more interest and greater expectations for success with IT careers.

Table 1. List of IT careers (provided on student survey)

- Computer scientist
- Computer systems analyst
- Database administrator
- Webmaster
- Web developer/designer
- Computer support services
- Computer teacher

Expectations for Success in IT Careers

A one-way multivariate analysis of variance (MANOVA) was used to examine gender differences in participants' expectations for success (i.e., efficacy) for IT careers. In general, boys reported significantly higher levels of efficacy for IT careers than girls. These gender differences, however, varied depending on the specific career within the IT domain (see Table 2). Boys reported significantly higher levels of efficacy than girls for computer science, systems analyst, database administrator jobs, Web master, computer support services, and computer teacher careers. There were no significant differences with regard to expectations for success in Web development jobs.

Interest in IT Careers

A one-way MANOVA was also used to examine gender differences in participants' levels of interest in IT careers. In general, boys reported significantly higher levels of interest for IT careers than girls. These gender differences, however, varied depending on the specific career within the IT domain (see Table 3). Boys reported significantly higher levels of interest than girls for computer science, systems analyst, computer support services and database administrator jobs. There were no significant differences with regard to interest in Webmaster, Web development or computer teaching jobs.

Table 2. Means, standard deviations and gender differences in IT career efficacy

	Females		**Males**			
	M	***SD***	***M***	***SD***	***F***	Partial η^2
Computer Science	2.98	1.70	3.75	1.91	17.54***	.04
Systems Analyst	2.60	1.58	3.48	1.93	21.35***	.05
Database Administrator	2.18	1.50	2.88	1.96	16.23***	.04
Webmaster	2.67	1.64	3.50	2.05	16.98***	.04
Web Developer	3.37	1.86	3.44	2.02	0.10	
Computer Support Services	2.20	1.51	2.96	1.94	17.46***	.04
Computer Teacher	2.81	1.79	3.15	2.05	3.47*	.01

Table 3. Means, standard deviations, and gender differences in IT career interest

	Females		**Males**			
	M	***SD***	***M***	***SD***	***F***	Partial η^2
Computer Science	2.31	1.50	3.09	1.93	21.62***	.05
Systems Analyst	1.94	1.19	2.59	1.73	19.31***	.04
Database Administrator	1.64	1.04	1.98	1.46	7.25**	.02
Webmaster	2.19	1.40	2.46	1.73	3.14	
Web Developer	2.86	1.70	2.72	1.80	0.70	
Computer Support Services	1.64	1.04	1.89	1.40	4.11*	.01
Computer Teacher	2.10	1.52	1.97	1.45	0.82	

FUTURE TRENDS

The goal of the current study was to examine adolescents' attitudes about various IT careers in order to develop a better understanding of the gender gap within the IT industry in the U.S. Guided by Eccles and colleagues' (1998) expectancy-value model of achievement motivation, analyses were used to examine gender differences in adolescents' expectations for success and interest in IT careers.

Regardless of gender, interest in the IT jobs included in the current study was very low. On a seven-point scale, with larger values indicating more interest, the average level of interest ranged from 1.64 (database administrator) to 3.09 (computer scientist). Clearly, the majority of adolescents in the current study were not particularly interested in obtaining careers in IT. As expected, boys generally reported higher levels of interest for IT careers than girls. These gender differences, however, varied, depending on the specific career. Boys reported significantly higher levels of interest than girls for computer science, systems analyst, computer support services and database administrator jobs, though there were no significant differences with regard to interest in Webmaster, Web development or computer teaching jobs. Despite their low levels of interest, the adolescents (particularly male participants) did indicate moderate expectations for success in these careers. Thus, even though students were not necessarily interested in entering IT careers, they did feel confident that they could carry out these jobs.

Boys reported higher expectations for success than girls for all of the careers, with the sole exception of Web development. Although this finding is not entirely surprising, given recent research suggesting that males have significantly higher levels of computer efficacy than females (Kirkpatrick & Cuban, 2000; Sax et al., 2000), it is striking that such uniform gender differences were found with respect to expectations for success in IT careers.

Based on the literature suggesting that females are most interested in computers when they can see the relations between computer technology and applied and/or social contexts (Gilbert, 2002; Stabiner, 2003), it was expected that girls would be more likely to indicate interest in pursuing the more "people- and society-oriented" computer jobs, such as computer support services, Web design and teaching. Although these trends were not entirely true in the current study, it does appear as though gender differences were smaller and non-significant with respect to Web design and computer teaching. Overall, girls were most interested in Web development, and reported slightly higher interest for computer teaching and Web development careers than boys. Thus, it seems possible that females may become more involved in the technology workforce within the next several years, as these "people- and society-oriented" types of occupations become more visible and open to young women.

Although these findings have the potential to add to the literature on adolescents' computer attitudes, there are numerous future opportunities for research in this area. For example, the current sample was composed predominately of white adolescents from middle-class families in the northeastern part of the U.S. Thus, the current results cannot be used to understand race or ethnic-based differences in computer attitudes and activities, nor can the results necessarily be generalized across adolescents. Because computer access often varies by race, ethnicity and socioeconomic status (McConnaughey & Lader, 1998), and because some ethnic minority groups (e.g., Latino/as, African-Americans) are underrepresented in the current IT workforce (National Science Foundation, 2004), future research should attempt to measure IT career interest and expectations for success among adolescents from more varied backgrounds.

In addition, this study only provides information regarding students' *attitudes* about seven computer careers; no data is available on the actual careers these adolescents will eventually enter. Although the examination of adolescents' reports of interest and expectations for success in various IT careers offers an important first step in explaining gender differences in the IT workforce, future research should attempt to follow adolescents and young adults as they enter the workplace. Research that follows young adults on their educational and occupational pathways has the potential to help researchers understand why some individuals may choose to leave careers in the IT workforce, for example, even if they indicated interest in the field during high school.

Finally, the questions used to assess computer career interest and expectations for success were general and not presented in the context of other areas of work, possibly affecting the way adolescents answered the items. For instance, the survey generally asked adolescents how interested they were in having a job in Web development, rather than asking them if they were interested in designing Web sites for a particular type of company or industry. It is possible that adolescents would have indicated higher levels of interest if the computer careers were presented in the context of specific areas of work, such as health care, education or business.

CONCLUSION

The current findings corroborate Eccles and colleagues' (1998) expectancy-value model of achievement motivation. It appears as though females have less interest and lower expectations for success in IT careers during adolescence, and probably see technology as less important to their educational and career plans in comparison to their male counterparts (Mayfield, 2001). Importantly, most researchers involved in computer research agree that the basis of such gender differences in computer attitudes is essentially cultural and not related to inner ability. Females may simply value computers less than males, beginning in childhood (Kadijevich, 2000), and these early gender differences in computer attitudes likely preface the persistent under-representation of women in IT professions.

Findings from the present study could have implications for how educators introduce concepts and computer-related educational activities in the classroom. For instance, the current findings suggest that young women are especially interested in careers that involve Web development. To increase the number of female students in computer courses, schools may want to offer more classes that deal specifically with Web design and Web development, and school counselors should encourage female students to enroll in these courses. Teachers who instruct such courses may want to emphasize creativity, as well as the "people- and society-oriented" applications of Web design, helping students to see connections between careers in IT and the types of career characteristics they value most. Hopefully, classroom-level changes such as these will help encourage more females to consider careers in IT.

NOTE

This study was conducted at The Pennsylvania State University, in the Department of Human Development and Family Studies. Portions of this article were presented at the 2005 Women and IT Forum, Brisbane, Australia.

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KEY TERMS

Computer Scientist: Individuals involved in this occupation work as theorists, researchers or inventors. They have high levels of theoretical expertise, solve complex problems and create new technology. They also develop and design specialized computer languages, programming tools, knowledge-based systems and computer games.

Computer Support Services: Individuals in this occupation deliver customer service and help others with computer needs and concerns. They possess strong interpersonal skills and a basic understanding of how computers operate.

Computer Systems Analyst: Individuals in this occupation solve computer problems and use computer technology to help businesses or organizations.

Computer Teacher: Individuals in this position teach computer and technology classes at an elementary school or high school and help students with computer needs and questions.

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Database Administrator: People in this job set up computer databases, organize and store data and help people with their computer needs and questions.

Efficacy: An individual's belief about his or her capability to produce designated levels of performance.

Expectations for Success: Actual beliefs of students about their future performance on an upcoming task; expectations for success are positively related to achievement behaviors, such as choice and persistence.

Web Developer/Designer: People in this occupation are responsible for day-to-day Web site design and creation. Art or graphic design skills are desirable for Web developers.

Webmaster: These individuals are responsible for all technical aspects of a Web site, including performance issues, such as speed of access. They also approve and edit the material included on Web sites.

Gender Differences in Adoption and Use of a Healthcare IT Application

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INTRODUCTION

Information technology (IT) adoption and diffusion is a central concern of information systems research and practice. The most widely-accepted method in IT adoption and diffusion research, the technology acceptance model (TAM; Davis 1989), posits that perceived ease of use and perceived usefulness are fundamental determinants of user acceptance. However, TAM and its subsequent research makes little or no reference to gender effects (Adams, Nelson, & Todd, 1992; Chin & Gopal, 1995; Venkatesh & Davis, 2000), despite the fact that researchers have shown that socio-cultural factors, such as gender and ethnic differences, influence human perceptions and behaviors (Hofstede, 1980). These socio-cultural factors can result in differences in user responses to technology innovations (Gefen & Straub, 1997).

Aiming to provide theoretical extensions to the TAM model, researchers have shown that gender differences may relate to beliefs and use of IT. For instance, males and females are found to demonstrate distinct adoption behavior in use of a wide spectrum of IT applications, such as e-mail (Gefen & Straub, 1997), mobile telephony (Ling, 2000) and Internet (Kraut, Scherlis, Mukhopadhyay, Manning, & Kiesler, 1996). Nevertheless, the exact gender effect remains a controversy. Some researchers believe that females are less technology inclined, less motivated and, therefore, less competent in masculine computer and technology culture (Wilder, Mackie, & Cooper, 1985; Qureshi & Hoppel, 1995). Others, in contrast, argue that females have the ability to be proficient in adopting new technologies (Turkle, 1995). Some research results indicate that females tend to favor some technology innovations and use them more effectively than males, such as computer-mediated communication (Kraut et al., 1996; Morahan-Martin & Schumacher, 1997).

In health care, influence of physician gender has long been noted in resident education and many practice areas. Researchers find the procedural and obstetrical care pattern of practice differs between male and female residents (Chaytors, Szafran, & Crutcher, 2001), and physician gender significantly affects treatments in adult primary care practice (Boulis & Long, 2004). An understanding of these socio-cultural issues is also of vital importance towards success of health care IT applications. This study is thereby designed to assess medical residents' acceptance and adoption of a Clinical Reminder System (CRS), by examining several key user characteristics that may relate to adoption and use of the system.

BACKGROUND

CRS is a class of computerized clinical decision support systems (CDSS) that send just-in-time alerts to clinicians when potential errors or deficiencies in patient management are detected. Beneficial outcomes of CDSS have been documented in many studies along a number of dimensions, including compliance with treatment standards, reduced costs and improved health outcomes (McDonald, Hui, Smith, Tierney, Cohen, Weinberger et al., 1995; Curtin, Hayes, Holland, & Katz, 1998). Several systematic reviews have also shown that CDSS can be an effective means of implementing medical guidelines to enhance clinical performance in wide-ranging aspects of medical care (Hunt, Haynes, Hanna, & Smith, 1998; Kaplan, 2001). However, most of these studies either focus on the accuracy and relevance of the computer-aided recommendations, or use experimental or randomized controlled clinical trials (RCCT) designs to assess system or clinical performance. Very few studies of CDSS involve a naturalistic design in routine settings with real patients (Kaplan, 2001). It is not clear whether a CDSS that has been shown to be effective in a laboratory setting will be fully utilized by end-users in clinical environments, and whether these users will adapt their practice style to efficiently accommodate computer-generated reminders.

Clinical users also differ in many ways. It has been recognized that individual users' experiences and their opinions or reactions to a technology make a difference in whether or not the technology will be adopted (Straub, Limayem, & Karahanna-Evaristo, 1995). Nevertheless, few studies have used individual-level data to measure the magnitude of user differentiation and the impact of such differentiation on technology adoption.

The present study aims to address some of these limitations. First, the system under evaluation, CRS, has been integrated into the daily operations of an ambulatory clinic. Second, longitudinal usage data for an evaluation period of 10 months were collected from computer logs, providing an objective and non-intrusive measure of the actual use over time. Third, a novel developmental trajectory method is applied to the usage data to identify groups that demonstrate distinct adoption behaviors, and to relate estimated group configurations to a variety of user characteristics.

The next section describes CRS and its basis in principles of evidence-based medicine. The study site and data collection procedures are then discussed, followed by a presentation of the trajectory analysis method for analyzing the usage data. The findings are presented next, and the final section presents some concluding remarks.

CRS AND EVIDENCE-BASED MEDICINE

Evidence-based medicine is the distillation of a large volume of medical research and standards into treatment protocols for diseases and preventive care procedures that represent the most accurate knowledge available (Sackett, Rosenberg, Muir Gray, Haynes, & Richardson, 1996). Evidence-based medicine has been widely applied to systematically review, appraise and use clinical research findings to aid the delivery and provisioning of optimum clinical care to patients.

The clinical decision support application that we developed, CRS, incorporates evidence-based medicine principles to assist in patient management decisions. It integrates the hospital's administrative, laboratory and clinical records systems into a single application, and uses patients' current medical status to provide reminders to clinicians at the point of care that reflect evidence-based medicine guidelines. Reminders generated by CRS take the form of recommendations to have tests scheduled and performed, receive vaccinations, alert clinicians to review abnormal test results or closely monitor patients with medical conditions that require unscheduled intervention. The CRS deployed at the time of this study is a distributed windows application based on client-server architecture. The clients are written in Visual Basic and communicate with an Oracle database server via the hospital's internal computer network. Evidence-based medicine guidelines are programmed in Oracle PL/SQL procedures.

STUDY SITE AND DATA COLLECTION

The study was conducted in the primary care clinic of an urban teaching hospital offering comprehensive health care services. Given the availability in every exam room of desktop computers installed with CRS, residents used the system during patient encounters.

Data collection started on February 1, 2002. In this study, we report 10 months of usage data to identify distinct user groups and maturation of their interaction with the reminder system. There were 44 active residents registered in the application. Activities generated by three of them are removed from the analysis since there were no visits recorded for these residents in 6 or more continuous months.

We have included in the study several key attributes of users that may relate to their human, contextual and cultural characteristics that in turn affect system use. These attributes are: general demographics including gender and citizenship (U.S. vs. non-U.S.); computer literacy identified by use, knowledge and optimism of computer systems; and frequency of encounters (work load). These attributes are found to influence adoption behavior in some other contexts (Berner & Maisiak, 1999). We have excluded a few other potentially influential attributes, because they are (a) invalid in the context, such as medical specialty (all users are internal medicine residents); or (b) lack of variation in the sample, such as age (mean 29.6, standard deviation 2.1); (c) sample size too small for defined subgroups, such as year of residency; or (d) inaccessible to us in recorded form, such as evaluation of residents' clinical performance (due to confidentiality concerns).

DEVELOPMENTAL TRAJECTORY ANALYSIS

We use a novel method, developmental trajectory analysis (DTA), to study user adoption behavior of this reminder system. DTA is a semi-parametric, group-based approach for identifying distinctive groups of individual trajectories within the population and for profiling the characteristics of group members (Nagin, 1999). It has provided valuable insights into studying physical aggression among youth (Nagin & Tremblay, 1999, 2001) and Web utilization and saturation patterns (Christ, Krishnan, Nagin, Kraut, & Guenther, 2001).

A "developmental trajectory" describes the course of a developmental behavior over age or time. DTA assumes that the population is composed of a mixture of distinct groups defined by their developmental trajectories. This method is useful for modeling unobserved heterogeneity in a population, where trajectories vary greatly across population subgroups both in terms of the level of behavior at the outset of the measurement period and in the rate of growth or decline over time. DTA also provides a multivariate procedure to examine impacts of individuals' characteristics on group membership probability, so the influence of the social-cultural factors, such as gender differences, can be evaluated.

RESULTS

The Trajectories

The developmental trajectories obtained from usage data are depicted in Figure 1. Bold and light lines denote observed and predicted trends, respectively. Observed data values are computed as the mean use rate of users assigned to each of these groups identified by estimation, and expected values are computed using DTA model coefficient estimates. We label these three groups as "Light" users, "Moderate" users and "Heavy" users, each comprising 17, 15 and 9 individuals (41.46%, 36.59% and 21.95%, respectively, of all users).

Figure 1 also reveals developmental trends of the adoption behavior. Users classified as "Light" initially utilized the system in about 35% of their encounters, and this rate remained steady over the 10-month study period. "Moderate" users had the highest initial use rate, about 70%, but this rate consistently decreased over the study period to a level comparable with that of the "Light" users. "Heavy" users had an initial use rate of approximately 50%, and this rate increased consistently to about 100% at the end of the study period. Changes in the use rate for members of the moderate group are of particular interest, since it indicates "Moderate" users demonstrated strong enthusiasm initially, while followed by a gradual decline in their use of the system.

Group Profiling

We now examine the association between adoption behavior and user characteristics to identify potential causal relations. Group profiles are shown in

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Figure 1. Developmental trajectories of three distinct groups

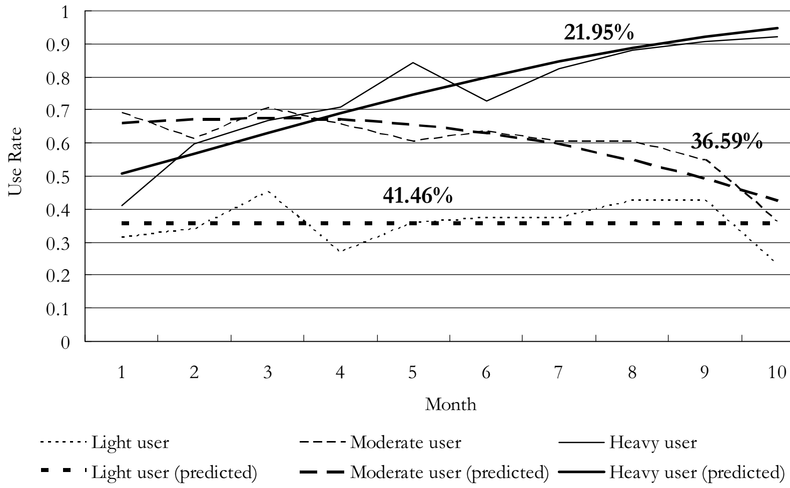


Table 1. Group profiles

User Characteristics	All	User Groups		
		Light	Moderate	Heavy
Female (%)	43.90	41.2	33.3	66.7
Male (%)	56.1	58.8	66.7	33.3
Non-U.S. citizen (%)	48.78	23.5	66.7	66.7
U.S. citizen (%)	51.22	76.5	33.3	33.3
Number of appointments *	14.04	14.13	14.12	13.75
Number of visits *	8.44	8.50	8.67	7.95
Number of visits w/ system use *	4.53	3.02	5.45	5.87
Computer use score	33.54	33.0	33.56	34.13
Computer knowledge score	32.96	36 **	31.33	31.38
Computer optimism score	53.19	48.56	52.78	58.88 ***

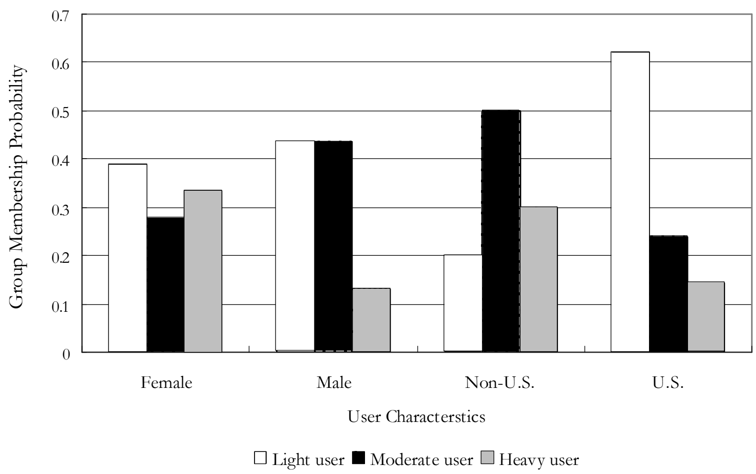
* Monthly average
** Significantly higher than that of the moderate user group at .05 level
*** Significantly higher than that of the light user group at .001 level

Table 1. For example, female users account for two-thirds of the heavy user group, whereas male residents account for two-thirds of the moderate user group. The lower portion of Table 1 shows real-scale measures. On average, each resident saw 8.44 patients each month during the study period (standard deviation 1.89); the maximum count of daily patient encounters is five, but this only occurred a few times. Since the frequency of patient encounters, monthly or daily, was low and relatively evenly distributed among residents, we do not deem this variable useful and will exclude it from further analysis.

The last three rows of Table 1 present the residents' computer literacy assessments obtained from Cork's instrument, measuring physicians' use of, knowledge about and attitudes toward computers (Cork, Detmer, & Freidman, 1998). These three items can be roughly interpreted as how often physicians currently use computers, how much they know about computers, and their relevant beliefs and attitudes. As indicated by Table 1, "Light" users have the highest computer knowledge score and "Heavy" users have the highest computer use and computer optimism scores.

Figure 2 shows the group membership probabilities for each of the categorical variables. For example, male users tend to cluster in the light and the moderate user groups, and non-U.S. citizens are more likely to be present in the moderate user group,

Figure 2. Mean group membership probabilities for gender and citizenship



whereas U.S. citizens are more likely to be present in the light user group.

Group profiles (see Table 2) are a collection of univariate contrasts. A multivariate procedure is provided in the DTA model to construct a more parsimonious list of predictors to sort out redundant variables as well as to control for potential confounds. Table 2 shows the impact of the covariates of interest on group membership probabilities. The upper panel shows coefficient estimates and t-statistics. We use the light user group as a *contrast group*. That is, for the light user group, the impacts of the covariates are set to zero, and the coefficient estimates for other groups are interpreted as measuring the impact of the covariates on group membership probabilities relative to that of the contrast group.

Table 2 shows the impact of gender on group membership probabilities. If a user is female, the probability of her being in the heavy user group is increased while the probability of her being in the moderate user group is decreased, compared to the probability of membership in the light user group. The lower panel of Table 2 shows the predicted membership probabilities based on multinomial logit model coefficient estimates. For each row, the impact of a single factor is evaluated. Being a female alone increases the probability of membership in the heavy user group. Similarly, having non-U.S. citizenship alone decreases the probability of member-

Table 2. The impact of user characteristics on the probability of assignment to usage groups

Variable condition	User Group		
	Light	Moderate	Heavy
Multinomial logit coefficients			
Gender – female	-	-.56 (-0.62)	.27 (0.24)
Non-U.S. citizen	-	1.67 (1.87)	.68 (0.6)
Computer use	-	.045 (.39)	.23 (1.46)
Computer knowledge	-	-.09 (-.985)	-.06 (-.546)
Computer optimism	-	.31 (2.18)	.98 (1.59)
Predicted membership probabilities based on multinomial logit model coefficient estimates			
Without user characteristics	.49	.36	.15
Gender – female only	.54	.27	.19
Gender – male only	.46	.41	.12
Non-U.S. citizen only	.29	.57	.14
U.S. citizen only	.63	.22	.15

ship in the light user group and increases the probability of being in the moderate user group. Impact of computer literacy also emerge: A higher score on previous computer use or computer optimism increases the probability of being in the heavy user group, and a higher score on computer optimism increases the probability of being in the moderate user group. In contrast, computer knowledge does not seem to affect usage significantly.

CONCLUSION

In this study, we assess 41 medical residents' acceptance and adoption of a clinical reminder system for chronic disease and preventive care management in an ambulatory care environment. We use a novel developmental trajectory approach to identify distinct groups, following distinct usage trajectories, among those who recorded use of the reminder system within an evaluation period of 10 months. We find that users in this study can be clustered into three groups: "Light" users, who used the system steadily over time for about 35% of their patient encounters; "Moderate" users, whose initial use rate was the highest (70%) among all groups but declined steadily to a level comparable with that of "Light" users; and "Heavy" users, whose use rate, initially moderate (50%), increased to nearly 100% at the end of the evaluation period.

We find that several user characteristics are correlated with usage levels and group membership probabilities. Females are more likely to be frequent users, while males demonstrate the other extreme. Female residents' tendency to comply with system use may be explained by social influence processes, such as subjective norm and their inclination to follow orders. Besides the gender influence, citizenship and attitude towards computers also play a role: Non-U.S. citizens are more likely to be frequency users than U.S. citizens, and computer optimism, rather than previous use and knowledge of computers, increases a user's probability of being a frequent user.

With awareness of such potential causal relations, researchers and practitioners can utilize user characteristics as a means of predicting future levels of usage and adoption. Gender-differentiated training programs and other just-in-time intensive strategies also can be developed and implemented to accomplish higher levels of technology acceptance and use and to minimize undesirable adoption behaviors.

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KEY TERMS

Clinical Decision Support System (CDSS): A class of computer applications typically designed to integrate a medical knowledge base, patient data and an inference engine to generate case-specific advice. They intend to support clinical diagnosis and treatment plan processes and promote use of best practices, condition-specific guidelines and population-based management.

Clinical Reminder System (CRS): A computer system developed at Carnegie Mellon University and The West Penn Allegheny Health System. This system uses patients' medical history to provide just-in-time reminders to clinicians at the point of care that reflect evidence-based medical guidelines.

Developmental Trajectory Analysis: A semi-parametric, group-based approach for identifying distinctive groups of individual trajectories within the population and for profiling the characteristics of group members.

Evidence-Based Medicine: The distillation of a large volume of medical research and standards into treatment protocols for diseases and preventive care procedures that represent the most accurate knowledge available.

Health Informatics: A field of study concerned with the broad range of issues in the management and use of biomedical information, including medical computing and the study of the nature of medical information itself.

Information Technology Adoption: A micro process that focuses on the stages through which an individual passes when deciding to accept or reject the innovation of an information technology.

Medical Guideline: A document with the aim of guiding decisions and criteria in specific areas of health care, as defined by an authoritative examination of current evidence (evidence-based medicine). In the U.S., the National Guideline Clearinghouse publishes and maintains guidelines.

Random Control Trails (RCT): In RCT, study participants are assigned at random to either a control or treatment group to avoid bias and assure more objective results. People in the treatment group receive the new drug or are treated with the new device; the control group participants receive a more standard treatment, no treatment or a placebo (a look alike that has no active drug).

Technology Acceptance Model (TAM): An information systems theory that models how users come to accept and use a technology. The model suggests that when users are presented with a new software package, perceived usefulness and perceived ease-of-use are two primary factors that influence their decision about how and when they will use it.

Gender Differences in an Austrian IT Manufacturing Plant

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INTRODUCTION

Despite the gains women have made in the last three decades, a large body of research has recently emerged suggesting that major economic changes occurring on a global scale are having detrimental consequences for women's labor-market position. At best, these developments are judged to likely limit further progress toward gender equality (Human Resources Development Canada [HRDC], 2002).

While in industrialized countries the manufacturing and primary industries have declined, the service sector, where women have traditionally been concentrated, has grown quite substantially. The service sector is highly heterogeneous, encompassing both well-paid professional and technical occupations as well as low-skill, poorly paid occupations. A stratum of highly skilled, high-status workers has emerged, coupled with a large mass of technically semiskilled or unskilled workers who acquire their training on the job or in short courses lasting a few weeks (Standing, 1989). Wage polarization has accompanied the growing demand for highly skilled workers and declining demand for unskilled labor. Increasingly, the workforce is segmented into a primary labor market offering good wages, job security, and opportunities for advancement, and a secondary labor market of low-paid, contingent workers (Economic Council of Canada [ECC], 1991). Women, and especially visible minority women, remain overrepresented in the latter.

Much of the literature on gender differences in the IT workforce has focused on the high-end IT jobs. Relatively little is known about low-end IT jobs and the role of gender. The IT industry is mainly a service-oriented industry. However, many of the tools used in these services have to be manufactured by IT manufacturers. In this study, we examine gender differences in the working conditions (job and organizational characteristics, and quality of working life [QWL]) of employees in a chip-manufacturing plant.

BACKGROUND

Services make up nearly two thirds of employment in the Western world. The role of other industries is becoming less and less important. Most of the manufacturing of goods is being outsourced to developing countries such as China, India, and so forth. However, at the same time, high-tech manufacturing has been developed in the Western world. The manufacturing of high-tech goods such as medical equipment and aerospace, aviation, and high-end IT products still partly takes place. Also, in the high-tech manufacturing industries of the industrialized countries, jobs are often held by technically semiskilled or unskilled workers who acquire their training on the job or in short courses lasting a few weeks (Standing, 1989). Furthermore, these jobs are characterized by nonstandard forms of work, such as part-time, temporary, and shift work. Women are much more likely than men to have nonstandard employment (Krahn, 1995). Working nonstandard hours typically puts people out of sync with family and friends, and may have negative consequences for the functioning of family life and the stability of marriages (Presser,

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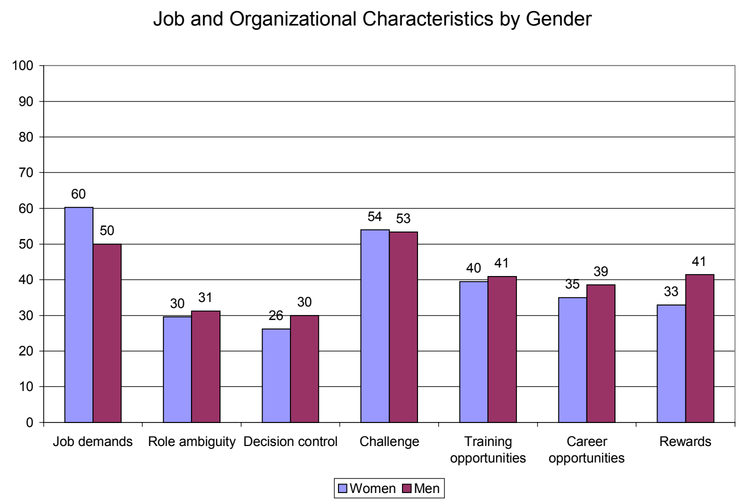
Table 1. Job positions by gender

	Blue Collar	White Collar	Total
Female	42 (93%)	3 (7%)	45 (7%)
Male	513 (86%)	80 (14%)	593 (93%)
Total	555 (87%)	83 (13%)	638 (100%)

Figure 1. Job and organizational characteristics by gender



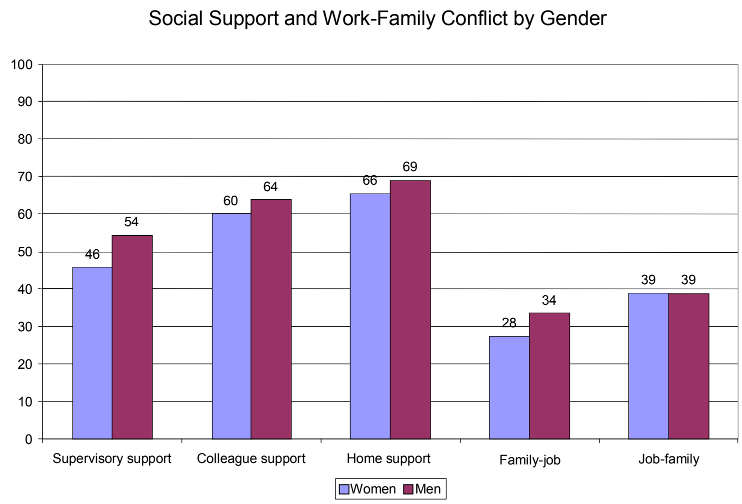
2003). Traditionally, women have been employed in the service sector. For example, the OECD (2005) reports that women are now overrepresented among public employees in all countries. In industrialized countries, 75% of women are employed in historically low-paying, service-sector jobs; 15 to 20% work in manufacturing; and some 5% in agriculture (International Labour Organization [ILO], 1995).

A large number of studies have dealt with gender differences in IT work. Earlier studies report that female IT workers have higher levels of psychosomatic complaints than male IT workers (Bradley, 1983). Furthermore, results have shown that monotonous and repetitive work with computers is more often performed by women (Evans, 1987), and women receive less skill upgrading by training than men (Gutek & Bikson, 1985). Therefore, quite a pessimistic picture of women and information-technology work emerges, putting an emphasis on the possibility that a polarization of qualification due to the technologies could be accompanied by a polarization between the sexes (Greve, 1987).

Some of the studies on job characteristics support this polarization hypothesis. In the study of Aronsson, Dallner, and Arborg (1994), the group of persons performing data-entry jobs—90% of whom were women—showed the highest level of psychosomatic complaints. On the other hand, programming personnel (mainly men) stated that due to the use of information technologies, their jobs had improved; they reported the lowest level of psychosomatic complaints. Further studies found more negative impacts of information technologies on work for women (Cressey, 1992; Hackett, Mirris, & Scales, 1991; Parasuraman & Igbaria, 1990).

While Austria has a general female employment rate clearly above the OECD average (in 2003, 61.5% of the women of working age were employed, as compared to an OECD total rate of 56.3% and an EU-15 rate of 56.1%; OECD, 2005), the female employment rate in the electrical and IT industries is relatively low. Especially low rates are found for blue-collar work, in which the female employment rate is 14.3%. In this article we compare the job and organizational characteristics, social support, work-family conflict, and quality of working life of male and female employees in an Austrian IT manufacturing plant.

Figure 2. Social support and work-family conflict by gender



MAIN THRUST OF THE ARTICLE

Data was collected at a chip-manufacturing plant in Austria. The questionnaire used was the German version of the American questionnaire used in the project *Paths to Retention and Turnover in the IT Workforce: Understanding the Relationships between Gender, Minority Status, Job and Organizational Factors* (http//cqpi2.engr.wisc.edu/itwf/index.html). For a full description of the questionnaire, see Carayon, Schoepke, Hoonakker, Haims, and Brunette (in press) and the other chapters by Carayon and Hoonakker in this encyclopedia. The German version of the questionnaire has been shown to be reliable and valid (Cronbach's alphas between 0.66 and 0.92). All scale scores in the questionnaire have been recoded to a score between 0 (lowest) and 100 (highest).

A total of 677 employees filled out the questionnaire (response rate was 74%). The female employment rate in the Austrian branch of the IT company is 13%. The majority of the sample (93%) is male. Thirty-eight percent of the sample is between 35 and 44 years old. The women in the sample are significantly older than the men: 57% of the men are older than 35 years, as compared to 81% of the women (Chi^2=13.6, $p<0.001$). Sixty percent of the men and 58% of the women in the sample have children.

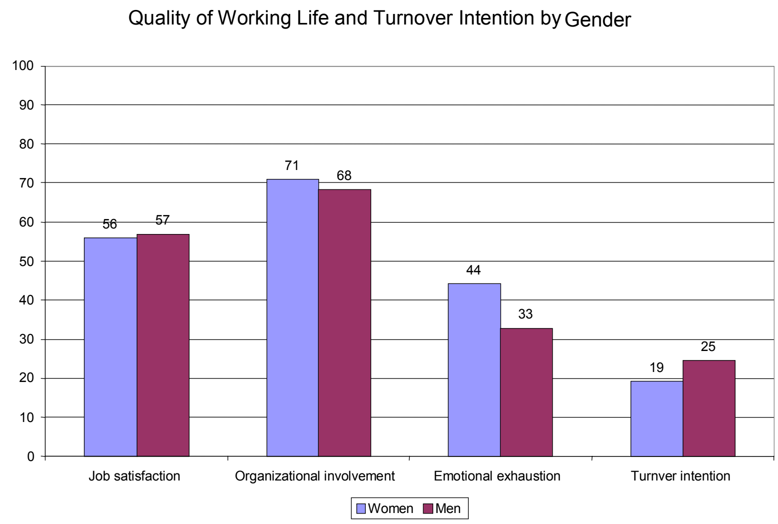
The average job tenure is 10.6 years, with slightly higher values for women (t=-6.03, $p<0.001$). As compared to the men in the sample, women have better education (14% men vs. 29% women have high-school education or better; Chi^2=8.21, p=0.02). Significantly more women have part-time jobs, although the percentages for both sexes are small (8% women vs. 1% men). If we exclude the women who work part time, both men and women work on an average 41 hours a week. There are no significant differences with regard to day-shift work: 84% of the women and 88% of the men work in alternate shifts. By law, only men are allowed to work in night shifts. There are no differences in self-reported income. Table 1 shows job positions by gender.

Eighty-seven percent of the sample holds a blue-collar job and 13% a white-collar job. The white-collar jobs consist mostly of supervisors. Although there are very few female white-collar employees, the gender differences are not statistically significant (Chi^2=1.72, p= 0.19).

Results show that there are few gender differences in job and organizational characteristics. However, the differences in psychological demands and rewards are statistically significant: Women perceive the job demands as higher than men ($p<0.001$), and men are more positive about the rewards than women ($p<0.01$).

Results show that the social support men receive is higher than the social support women receive. The differences in supervisory social support are statistically significant ($p<0.05$). Men complain more

Figure 3. Quality of working life and turnover intention by gender



about family-work spillover. However, these differences are not statistically significant.

Results show that there are some minor gender differences in quality of working life and turnover intention. Women report higher emotional exhaustion than men. The difference in emotional exhaustion between men and women is statistically significant ($p<0.01$).

FUTURE TRENDS

Due to major economic changes occurring on a global scale, recent research has shown that these changes may have detrimental consequences for women's labor-market positions, which may have a negative effect on gender equality. Historically, most women have been employed in the service sector and there are relatively few in manufacturing. Recently the service sector has undergone major changes. A stratum of highly skilled, high-status workers has formed, coupled with a large mass of technically semiskilled or unskilled workers who acquire their training on the job or in short courses lasting a few weeks. Increasingly, the workforce is segmented into a primary labor market offering good wages, job security, and opportunities for advancement, and a secondary labor market of low-paid, contingent workers, whose working conditions start to resemble the working conditions of manufacturing: nonstandard forms of work, such as part-time, temporary, and shift work. Women are much more likely than men to have nonstandard employment.

CONCLUSION

Although there are, as we expected, relatively few women in our sample of IT manufacturing workers, we were interested in gender differences in IT manufacturing for two reasons. First, although there is some literature about gender differences in the IT sector, there is relatively little known about IT manufacturing. Second, recently, within the service sector a secondary labor market of low-end jobs has been created whose characteristics have started resembling working conditions in the manufacturing industry.

Results show that there are relatively few gender differences with regard to job and organizational characteristics, QWL, and turnover intention in our study. However, women perceive higher job demands than men. They complain more often than men about the fact that their jobs often require them to work very fast ($p<0.01$), that there often is little time to get things done ($p<0.01$), that they often have problems to keep up with new technology ($p<0.01$), that they often have to stay at work because of customers' demands ($p<0.01$), and that they are more often overwhelmed by their workloads (p<0.001). Furthermore, they also report a higher rate of emotional exhaustion. They feel significantly more emotionally drained from their work (p<0.001), feel more often fatigued when they get up in the morning and have to face another day on the job (p<0.01), and feel more often that working all day is really a strain for them (p<0.001). However, they do not feel more frustrated by their job.

Men perceive better job resources, that is, more rewards and more social support. Therefore, the data may be seen as weak confirmation of the polarization hypothesis for the working conditions in this IT manufacturing plant in Austria. In similar job conditions, men seem to have better resources to deal with the job demands. Differences in the support scales indicate that increased work-nonwork role conflict may be the reason for the higher values in emotional exhaustion in women. If women and men do not share domestic responsibilities equally, then there is no wonder women are more exhausted at work!

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KEY TERMS

IT Manufacturing: The sector that manufactures information-technology products, such as chips, computers, cell phones, networking devices, and so forth.

Job Satisfaction: Describes how content an individual is with his or her job. There are a variety of factors that can influence a person's level of job satisfaction. These factors include the level of pay and benefits, the perceived fairness of the promotion system within a company, the quality of the working conditions, leadership and social relationships, and the job itself (the variety of tasks involved, the interest and challenge the job generates, and the clarity of the job description or requirements).

Job Stress: Job stress is measured as burnout or the exhaustion of emotional and/or physical strength as a result of prolonged stress and/or frustration.

Organizational Involvement: The extent of an individual's involvement in an organization.

Quality of Working Life (QWL): Represents the quality of the relationship between employees and their total working environment, with human dimensions added to the usual technical and economic considerations.

Turnover Intention: The intention of an individual to move in or out of employment with a particular firm or organization.

Gender Differences in Defining Technology

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Our understanding of the computing profession strongly influences our approaches to education and research. (Peter Denning, 1991, p. 129)

INTRODUCTION

There is an alarming trend in the information technology (IT) career field: fewer women than in the past are entering the IT educational pipeline (Camp, 1997; Cukier, Shortt, & Devine, 2002; Whitaker, 2000; Woszczynski, Myers & Beise, 2004). Researchers have discovered a number of possible causes for this dearth including lack of female role models (Ahuja, 2002; Trauth, 2002), the "nerd" image (Braham, 1992; Menagh, 1998; Van Brussel, 1992), and family distractions (Ahuja, 2002; Trauth, 2002). With approximately 50% of the general workforce comprised of women in the United States, this statistic is alarming. At the same time, the IT skills shortage is rapidly becoming a global concern (Cukier et al., 2002; Trauth, 2002; Verton, 2004). The message is clear: something radical needs to be done now to attract and retain qualified, talented women to the IT field.

The general understanding of IT can be seen as an obstacle to attracting job candidates. When junior and senior high school students were asked about their perceptions of IT workers, the majority responded with terms like "weird", "nerd", and "geek (Menagh, 1998; Van Brussel, 1992). The derogatory tone is unmistakable since socialization practices of young girls influence their career choices long before they enter universities (Ahuja, 2002). The basic definition of IT learned through industry and government agencies invokes the areas of computer science and engineering (Cukier et al., 2002). The lack of a concise definition of IT precludes development of a deeper understanding of the problem (Woszczynski et al., 2004). In the past, technology workers have been required to possess strong mathematical and technical skills to create algorithms and to program in tedious computer languages (Weinberg, 1971). This practice ignores the multidimensional nature of IT work. Many workers enter the IT field through paths other than computer science or engineering education programs. So, why is the definition of IT so narrowly focused on these two areas?

The purpose of this article is to explore the influence of gender on perceptions of technology. Next, relevant literature from the information systems field is reviewed, followed by a comparison of definitions found in academic articles, textbooks, and practitioner journals. The next section describes the methods and results of a 2004 study on definitions of technology of undergraduate students (Buche, 2005). Themes extracted from their definitions are compared based on gender. Following the results, a first attempt at a gender-sensitive definition is proposed. The article ends with future trends and conclusions for managers and academics.

BACKGROUND

The role of IT professionals has been changing from that of a highly technical programmer (Weinberg, 1971) to a systems analyst, creating solutions to relevant business problems (Humphrey, 1997; Markus & Benjamin 1996, 1997). These job title changes signal continuous enhancement of responsibilities and tasks. The most obvious evolution is the increasing emphasis on problem solving, project management and communication, thereby bridging the gap between business end users and traditional software programmers. The skills required to be successful in these positions are broader than those found in computer science or engineering fields (Lee, Trauth, & Farwell, 1995). In spite of this realization, businesses continue to hire based on technical skill sets (Cukier et al., 2002).

Historically, feminist writings have addressed the definition of technology as being associated with male/masculine values. As Stewart Millar (1998) argues "[I]n contemporary western culture, men are assumed to make the machines, and, if culturally appropriate, women may use them." This argument is grounded in " ... traditional images of masculinity ... [representing] ... the technological 'Progress of Man' from so called barbarism to civilization ... " (p. 15). According to Stewart Millar "[s]uch an identification is reinforced by millennia of historically constituted gender constructions that have come to define our very notions of what it is to be male and female" (p. 15).[1] Technology has been defined and is often understood within this masculine social, cultural, political, and economic context (Wilson, 2004).

Denning divides the multiple areas of IT professionals into three general categories based on functions and expertise (2001, p.16). First, IT-specific disciplines include the highly technical specialties like artificial intelligence and computational science. The second group, IT-intensive disciplines, relies heavily on technology, but has a separate focus (e.g., financial services and telecommunications). The last set, IT-supportive disciplines, includes professional services that assist others in the use of technology (e.g., help desk technicians and system administrators). This conceptualization of technology includes more specialties with female workers (Woszczynski et al., 2004). The next section introduces a number of definitions of technology extracted from the IT literature.

Comparison of Definitions of Technology and Information Technology

A concise definition of the term technology is often absent from academic articles and textbooks in the IT field. Authors either assume that the term in self-explanatory, or they choose to allow the reader to define the term individually, according to background and personal expertise. A comparison between the definitions will reveal some of the socio-cultural forces that have helped to shape the IT field and perceptions of potential female IT professionals.

"Whenever we see the word *technology* or *technique*, we automatically think of machines" (Ellul, 1964, p. 3). Ellul divides the terms into two parts: technical operations and technical phenomenon. The technical operations contain the view of the process of creating innovation, while the technical phenomenon includes the products created.

Ferré (1988, p. 14) also acknowledges two aspects when defining technology. First, technology is the "*study* of practical arts or (by analogy with bio*logy* or anthropo*logy*) the *science* of the industrial arts." Secondly, technology "refers to the practical arts and products themselves." He discusses technology as both a science and the artifacts or tools produced by innovation.

Cukier, et al., state that "most of the work to date, even by feminists, has accepted the prevailing idea that 'information technology' is virtually synonymous with engineering and computer science" (2002, p. 8).

From current textbooks, information technology is "a term used to refer to a wide variety of items and abilities used in the creation, storage, and dispersal of data and information. Its three main components are computers, communications networks, and know-how," (Senn, 2004, p. 13). The tools definition is obvious in Laudon and Laudon (2004, p. 14) textbook: "Information technology is one of many tools managers use to cope with change." Jessup and Valacich (2003, p. 8) define technology as "any mechanical and/or electrical means to supplement, extend, or replace human, manual operations or devices", and "information technology refers to machine technology that is controlled by or uses information." This definition focuses almost entirely on computer-based solutions.

Although there are similarities between the definitions, the general consensus appears to support technology as existing in engineering and mathematical domains. The next section discusses a study that investigates the influence of gender in the way technology is defined.

METHOD

Over three semesters, the researcher collected definitions of the term "technology" from 197 undergraduate students participating in the core course Information Systems/Information Technology Management (Buche, 2005). The students were primarily business majors in a small, Midwestern university. The students had previously completed a basic

Table 1. Demographics from student respondents

Gender		
Female	54	27%
Male	143	73%

Table 2. Familiarity with technology by gender

Comfort Level	Females (n = 54)	Males (m = 143)
Novice	15 (28%)	18 (13%)
Intermediate	39 (72%)	82 (57%)
Expert	0	43 (30%)

computer skills course, so they had some foundational knowledge of the subject. During the first class period, each student was instructed to write out a definition for the term "technology" on a personal introduction card. Although no artificial incentive was offered for participation, most of the students provided a response. Time limits were not imposed, so students could write as much or as little as they deemed appropriate. Other requested information on the card was name, major/concentration, status (expected graduation), e-mail address, personal assessment of comfort level with technology (Novice/Beginner, Intermediate, or Expert), desired learning outcome of the course, and future career goals.

Since context can impose a strong bias, it is important to note that the university's overall focus is primarily engineering disciplines. The business school comprises slightly less than 10% of the total enrollment. Within this engineering culture, business students often pursue more technologically intensive curricula than many comparison universities. Additionally, many business school students originally entered the university as engineering or computer science majors. These factors undoubtedly contribute to the results discussed later in the chapter.

The demographic information was analyzed for descriptive statistics (Table 1). Using a content analysis approach, a number of common themes emerged from the data. A coding scheme was developed based on previous literature and amended to fit the data. The concepts were aggregated into categories based on logical classifications (Table 3). The results of the study follow.

RESULTS

There are a number of interesting findings from the analysis. As shown in Table 2, none of the females identified themselves as experts. This is consistent

Table 3. Coding schema for technology by gender

Code	Definition	Example from Data
TOOL	Identifies a product or device that is used to meet a specific need or improve communication	Technology is anything in this world that allows us to freely communicate.
EFE	Refers to advancements to society, specifically easy, fast, efficient outcomes.	Technology is an advancement that allows people to perform tasks faster and more efficiently.
APL	Applied science – the use of scientific knowledge to produce change.	Technology is the utilization of scientific discoveries for practical use.
KNOWL	Creation of knowledge and understanding/learning for humans.	Technology is the knowledge available at that time.
CHG	Continuous change and development.	Technology is forever changing the ways we live and do things.
CMPT	Computer and electronic equipment.	Technology is the rapid growth of computers in today's society.
SCI	Research into possible advancements, "the study of..."	Study of how technologies affect all levels of the environment.
VISION	Futuristic developments of innovation.	Technology is one window of the future.

Table 4. Comparison of categories by order

Category	Females (n = 54)	Percentage of Total within the Category	Males (m = 143)	Percentage of Total within the Category
TOOL	20 (37%)	31%	44 (31%)	69%
EFE	15 (28%)	27%	41 (29%)	73%
APL	1 (2%)	5%	18 (13%)	95%
KNOWL	8 (15%)	42%	11 (8%)	58%
CHG	5 (9%)	50%	5 (3%)	50%
CMPT	0	0	6 (4%)	100%
SCI	2 (4%)	40%	3 (2%)	60%
VISION	0	0	3 (2%)	100%

with Bailyn's findings (1987) that women tend to report less confidence in their technical expertise than men in the study.

Second, females defined technology in terms of innovations that make life better or easier for the individual (TOOL and EFE; see Table 4). They also include gathering information or research (KNWL) as a benefit of technology. In contrast, definitions written by males focused more often on computer equipment (CMPT), visionary future advancements (VISION) and applied science (SCI).

Third, females identified improved communication (TOOL) as a key aspect of technology. However, the male students discussed the mechanical or electronic applications of science (APL) as important to technology.

Finally, most of the students, both males and females, assumed that technology leads to positive change (CHG). They identify change as leading to better, faster, or more efficient completion of daily tasks. Perhaps their universally positive impression of technology is influenced by the age and background of the students. However, that is beyond the scope of this chapter.

The next section attempts to reconcile the conflict of perceptions between males and females by proposing a gender sensitive definition.

Gender Sensitive Definition of Technology

Based on the synthesis of examples provided by the student participants, definitions provided by experts in the IT field, and iterations from various IT faculty, the following definition emerged.

Technology is the application of science to continuously improve processes, products, and services through innovation, and also the devices and mechanisms used in these endeavors.

This definition tries to cover the breadth of potential innovation, reaching beyond the boundary of computing and electronic resources. It also encompasses both processes and products, not restricting the focus to only tangible artifacts. In addition, a previously underdeveloped characteristic of technology is the service component. IT professionals provide a valuable service to computer systems users. The core reason for perpetuation of the field is to maintain current systems and to improve them in order to meet the requirements of the end users. The proposed definition also maintains the two-pronged format recognizable from earlier examples, including both the act of innovating and the outcomes of the activity. Researchers should view this as an initial draft and initiate dialogue to refine it into a sustainable, universal foundation for the IT area. Agreement on a definition would help to move IT to a more mature status as a field.

FUTURE TRENDS

Without dramatic changes in the socially disseminated definition of IT, the current frustrations of securing IT professionals with desired skill sets are sure to persist. The reason for this mismatch is that a conflict exists between the messages being sent—that IT is computer science and engineering—and the skills required by industry—soft skills, not being adequately taught in those disciplines. The desired skills are more likely found in the liberal arts, but hiring agents are restricted to searching for candidates with the proper educational pedigrees—computer science and engineering. The fundamental differences between the two disciplines are radical—people skills versus technical skills. It would be beneficial for U.S. academics to look into the European model of teaching IT as a combination of humanities and technical skills[2].

As a positive indicator, several management and academic initiatives are currently underway (Faulkner et al., 2004). Faulkner and her colleagues (2004) have evaluated Information and Communication Technologies in depth as a means of including women in the Information Society. The United Kingdom is taking a direct approach in attracting women to predominantly male fields by communicating opportunities, and by closing the salary and skills gaps (Millar, 2004). Individual universities in the U.S. are also taking steps to enhance IS education by blending technology with women's studies (Rothschild, 1989). However, empirical longitudinal outcomes are not yet available, so the impact of these efforts is not fully understood. Researchers and practitioners need to follow these programs and determine their value to the IT workforce.

The next section brings the discussion to a close, providing suggestions and observations to assist females who choose to enter the IT industry.

CONCLUSION

What impact would a gender-sensitive definition of IT have on the employment landscape? It is difficult to predict. One approach would be to enhance the boundaries of the IT field, including technology workers in the social sciences and communications technologies, thereby eliminating computer science or engineering backgrounds as a barrier for entry (Ahuja, 2002). Focusing on job tasks instead of educational discipline permits businesses to hire the right worker based on the skills necessary. Educational institutions have an added responsibility of teaching students the broad range of career opportunities that exist under the umbrella of IT (Rothschild, 1989; Woszczynski et al., 2004; Wraige, 2004). Recognizing that many undergraduate students subscribe to the gender-biased definition of technology, as shown in this sample, high schools (and even earlier) must develop ways to clearly communicate a gender-sensitive definition (Camp, 1997). According to Trauth (2002), the sociological and structural/institutional factors tend to impact females and discourage them from pursuing IT careers. This study also provides some support for Trauth's position opposing the essentialist argument (2002). The culture of the engineering campus apparently had a stronger impact than the stereotypical responses often credited to females regarding technology. Therefore, predominantly engineering and scientific universities must carefully review their institutionalized contribution to this gender imbalance—what message is being sent to female students? Undergraduate students are being influenced by terms like: "outsourcing" (e.g., Verton, 2004), "discrimination" (e.g., Trauth, 2002), "token female" (e.g., Kanter, 1977), and "the old boy network" (e.g., Melymuka, 2000a, 2000b). Without intending to, faculty members contribute to the propagation of the discriminatory message through selection of class materials. Through awareness comes understanding; and with understanding comes improvement. The IT field needs to become more inclusive of females, and one highly influential location for career planning is the university.

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KEY TERMS

Artificial: Anything man-made, as opposed to found in nature (Simon, 1998).

Gender: "A social category, by which the biological sexual division of the species is transformed into the social categories of feminine and masculine…socially constructed, reflected by behaviors, roles, and status…and the power imbalances that are perpetuated" (Rothschild, 1989, p. 711).

Information Technology: (1) The realm of engineering and computer science; (2) the application of science to solve problems.

IT Professional: Workers in the information technology field. For example, systems analysts, network administrators, programmers, help desk technicians, and computational scientists.

Old Boy Network: An informal communication network that conveniently excludes women. Since women are consciously excluded, the resulting business decisions are made within context that positions women as invisible. Such invisibility denies them a voice and does not take into account their experience.[3]

Outsourcing: The practice of hiring external firms or consultants to perform limited processes that are not core competencies for the firm.

Soft Skills: Knowledge, traits and abilities other than technical programming skills that are valued by corporations. These include problem solving, project management, communication, and organization.

Technology:

1. The use of innovation to solve problems or improve processes
2. Application of knowledge to optimize solutions
3. The study of artificial innovation
4. Artifacts and devices produced during the innovation process

ENDNOTES

[1] The author wishes to thank the reviewers for their valuable contribution in suggesting the inclusion of feminist writings in this section.

[2] This information was provided by one of the anonymous reviewers.

[3] Elaboration on this definition was provided by a thoughtful reviewer.

Gender Differences in Education and Training in the IT Workforce

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INTRODUCTION

Historically, women have had lower levels of educational attainment (Freeman, 2004; NCES, 1999), which in turn could negatively affect their opportunities in the labor market. However, in the past decade, this has changed dramatically. In general, more women have completed college, and more women have received bachelor's and master's degrees than men. Only in the highest level of education (PhD), men hold more degrees than women (NCES, 1999, 2002). In a recent study by the National Center for Education Statistics (NCES), Freeman (2004) presents an overview of the latest developments with regard to gender differences in educational attainment. Historically, females have tended to account for the majority of bachelor's degrees in fields that often lead to lower paying occupations, such as education and health professions, while males have typically predominated in higher paying fields, such as computer science and engineering. While some of these disparities persist, many changes have occurred since the 1970s. Certain fields in which men received the majority of degrees in the 1970s, such as social sciences, history, psychology, biological sciences/life sciences, and business management and administrative services, attained relative gender parity or were disproportionately female by 2001. While other fields, such as computer and information sciences, physical sciences and science technologies, and engineering, continue to have a larger proportion of males, the percentages of females majoring in those fields is increasing (Freeman, 2004). Between 1970 and 2001, the percentages of master's, doctoral and first-professional degrees earned by females increased substantially in many fields. However, advanced degrees conferred still tend to follow traditional patterns, with women accounting for the majority of master's and doctor's degree recipients in education and health, and men accounting for the majority of recipients in computer and information sciences and engineering. Higher levels of educational attainment are associated with certain labor market outcomes, such as higher labor force participation rates, higher rates of employment, and higher earnings (Freeman, 2004). A study by Igbaria, Parasuraman and Greenhaus (1997) looked at gender differences in the *information technology (IT) work force* with regard to education and experience, career history and attainments and career orientation. The results showed significant differences in educational attainment. A larger percentage of female IT employees in the study ended their formal education after attaining a bachelor's degree.

BACKGROUND

IT companies face many dilemmas when hiring new employees. Among these dilemmas are which recruits are qualified hires and how to ensure that their current IT employees amass critical skills needed for the company to stay competitive (Schwarzkopf, Mejias, Jasperson, Saunder, & Gruenwald, 2004). To answer this dilemma, many companies look for employees that have a formal post-secondary educational background in a technical field. The U.S. Department of Commerce (2003) has found that a four-year technical degree helps IT professionals get their foot in the door and get promoted. This is further emphasized in the projection from the Bureau of Labor Statistics (BLS) that between 2000 and 2010 almost 75% of the job openings within the IT professional level will require a minimum of a bachelor's degree (U.S. Department of Commerce, 2003). The IT training landscape is diverse, complete with traditional four-year university degree programs in computer science to newer training models, such as IT vendor-related training and certification programs and online learning (U.S. Department of Commerce, 2003). This vast array of education and training options provides a multitude of knowledge and skill sets that IT employees may enjoy. However, with such a diversity of IT training and educational pathways, it quickly becomes apparent that there is no "one-size fits all" approach to training for companies to take (U.S. Department of Commerce, 2003). Thus, IT companies are faced with the following challenge: how to keep pace with technological changes that have short life cycles (U.S. Department of Commerce, 2003). This challenge to keep pace with the ever-changing technology is felt by IT employees within companies as well. Stress has been recognized as a key factor affecting IT productivity and turnover, and can increase the costs that companies endure (Sethi, King, & Quick, 2004). It is essential for IT employers to examine the factors that contribute to their employees' stress. There are two stressors associated with training: one involves the need for appropriate training and the other involves the development of skills to complete tasks (Sethi, King, & Quick, 2004).

MAIN THRUST OF THE ARTICLE

The data analyzed in this article comes from the database of the project on "*Paths to Retention and Turnover in the IT Workforce: Understanding the Relationships between Gender, Minority Status, Job and Organizational Factors*" (http// cqpi2.engr.wisc.edu/itwf/index.html). Participants within the selected companies were identified based on two characteristics: (1) their job was within the information technology workforce, and (2) they have worked in their current job for two months or more. The data collection tool used is a 139-item Web-based questionnaire (Carayon, Schoepke, Hoonakker, Haims, & Brunette, 2005, in press).

Sample

The sample consists of five companies of varying size. Company 1 is a medium-sized Midwestern IT firm with 190 professionals. Company 2 is an eastern health care provider network with 895 IT professionals. Company 3 is a small western IT firm with 11 IT professionals. Companies 4 and 5 are both small eastern IT firms with 9 and 11 IT professionals respectively. Since the large company is not an IT company per se, the sample exemplifies the literature that 92% of IT professionals work in non-IT companies (ITAA, 2002). The total sample size is 624 with 46% women and 54% men (27 respondents did not report their gender). The average age is 40 years, with women being significantly older than men (t-test; $p<0.05$). Marital status (e.g., living with someone vs. not) is significantly different between women and men (χ^2 test; $p<0.05$): 65% of the women live with a spouse/partner, compared with 73% of the men. Parental status is not significantly different between women and men.

Measures

The items on training received were adapted from Lehto & Sutela (1999). To measure satisfaction with training opportunities, we developed our own scale, based on in-depth interviews we conducted in the pilot study (Carayon, Brunette, Schwarz, Hoonakker, & Haims, 2003). Respondents are asked whether they strongly disagree, disagree, agree, or strongly agree with statements such as: "I receive ongoing training which enables me to do my job better" (see Figure 1). Cronbach's alpha for the scale of satisfaction with training opportunities is 0.93. To measure quality of working life (QWL) we used existing scales that were found to be valid and reliable in previous research. Our own analysis has confirmed the validity and reliability of the scales used (Carayon et al, 2005, in press). All scales we used in the questionnaire were converted to scores from 0 (lowest) to 100 (highest). The following QWL fac-

Table 1. Highest level of education by gender

	Men	Women	Total
High school or GED	5%	4%	5%
Some college	21%	13%	17%
Bachelor's degree	39%	37%	38%
Some graduate or professional study	12%	15%	14%
Graduate or professional degree	23%	30%	26%
Total	100%	100%	100%

Table 2. Formal IT education by gender

	Men	Women	Total
No IT/computer-related formal schooling	18%	27%	22%
Some high school computer-related courses	2%	2%%	2%
High school computer-related degree/certificate	2%	0.4%	1.3%
Some technical college computer-related courses	10%	11%	10%
Technical college computer-related degree	8%	3%	6%
Some university computer-related courses	28%	33%	30%
University computer-related bachelor's degree	24%	13%	19%
University computer-related Graduate (MS, PhD) degree	8%	11%	9%
Total	100%	100%	100%

Table 3. Informal IT-education by gender

	Men	Women	Total
Training for certification	19%	6%	13%
Company provided training courses/seminars (besides certification training)	25%	40%	32%
Other training sources/seminars (not provided by a company; not including Web-based training)	7%	4%	6%
Self taught (without formal courses or training, but including Web-based training)	33%	17%	26%
Former work experience	12%	23%	17%
Other informal training	3%	9%	6%
Total	100%	100%	100%

tors were measured: job satisfaction (Quinn et al., 1971; $\alpha = 0.78$); organizational involvement (Cook & Wall, 1980; $\alpha = 0.72$) and stress or burnout (Leiter & Schaufeli, 1996; Maslach & Jackson, 1986, $\alpha = 0.91$). Turnover intention was measured using a single item: "How likely is it that you will actively look for a new job next year?" on a seven point scale ranging from 1: not at all likely-2-3: somewhat likely-4-5: quite likely –6- to 7:extremely likely (mean = 2.87, sd = 1.83).

Procedure

We used a Web-based survey to collect the data. For a detailed description of the Web-based survey system, see Barrios (2003). As described above, five IT companies participated in the study. The participating company sent out an e-mail to notify their employees of the survey and two days later, we sent employees an e-mail, describing the study, asking for their participation and providing them with a link to the Web-based survey. An informed consent procedure is integrated in the Web-based survey management system. The total response rate was 56%.

Results

Education and Training

First, we looked at gender differences in the pathways to an IT career. Tables 1, 2, and 3 show the results of this analysis.

Results show that the majority of participants in our study are highly educated: more than three-quarters of the respondents have at least a bachelor's degree. The differences between men and women

Table 4. Decision to seek an IT career

	Men	Women	Total
Prior to high school	3%	2%	3%
During high school	13%	6%	10%
During undergraduate degree program	24%	17%	21%
Prior to entering graduate degree program	4%	8%	6%
After earning highest academic degree	11%	16%	14%
During non-IT employment	37%	38%	38%
Other	7%	12%	10%
Total	100%	100%	100%

in level of education are statistically significant. Female employees in our sample are higher educated than men.

Results show some remarkable differences between men and women with regard to formal IT schooling. Women (27%) in our sample have more often no IT-related formal schooling than men (18%). Men are more likely to have a university computer-related bachelor's degree as compared to women.

Women (40%) received company-provided training more often than men (25%) and had their training through former work experience (23%) more often than men (12%). Men were more likely to receive training for certification and to be self-taught as compared to women.

Decision to Seek an IT Career

In the questionnaire, we asked respondents a question developed by Leventhal et al.: "At what point in your life did you first decide to seek an IT career?" Table 4 shows the results.

Results show that most respondents (38%) choose to seek an IT career during non-IT-employment: this result is similar for both men and women. Few of the respondents (3%) already knew prior to high school that they would seek an IT career. During their formal education, most respondents (21%) choose to seek an IT career during their undergraduate degree program. Analysis of the category "other" shows that many respondents choose to seek an IT-career after being laid off at a previous job.

Training

In the questionnaire, several questions were asked about training received in the past 12 months. Different scenarios were possible. Table 5 shows the results.

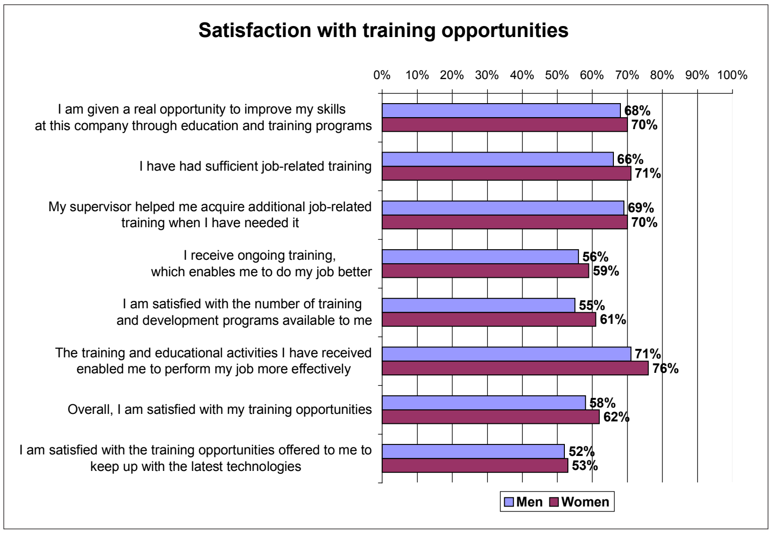
Results show that most respondents receive company sponsored training on company time (CSCT). There are significant gender differences in CSCT: women (74%) receive significantly more often CSCT

Table 5. Training scenarios over the past 12 months

	Percentage of employees that received training			If yes, how many days (in full days)?		
	Men	Women	All	Men	Women	All
Company sponsored/On company time (definition: company pays for training and pays you while you are attending training)	65%**	74%**	70%	6	5.5	5.7
Company sponsored/On your own time (definition: company pays for training, but you are not paid by your company for the time you spend training)	9%	8%	9%	14.5	4.6	9.8
Self sponsored/On company time (definition: you pay for the training, but your company pays for your time while you are attending the training)	9%***	3%***	3%	5.6	1.8	4.9
Self sponsored/On your own time (definition: you pay for the training and you are not paid by your company for the time you spend on the training)	21%**	12%**	17%	15.6	8.8	13.6

*Note: Differences between men and women are statistically significant at * $p<0.05$; ** $p<0.01$; *** $p<0.001$.*

Figure 1. Satisfaction with training opportunities



Note: Percentage of employees that agree or strongly agree with the statements

than men (65%). The average number of days of CSCT for women and men is 5.7 days per year. Men were more likely to get self-sponsored training than women, both on company time (SSCT) as well as in their own time (SSOT). The differences between men and women in number of days of training received over the past 12 months are not statistically significant.

Satisfaction with Training Opportunities

Figure 1 depicts the results of the analysis on gender differences with regard to satisfaction with training opportunities. Results shows that half to two-thirds of the respondents are satisfied with training opportunities to improve their skills. There are no gender differences in satisfaction with training opportunities.

Impact of Training on QWL and Turnover

Although more than half to two-thirds of the respondents are satisfied with different aspects of training opportunities, one-third to nearly half of the respondents are not satisfied with several aspects of training. We divided the sample into two groups. The first group is not satisfied with the different training opportunities (a score between 0 and 50 on the satisfaction-with-training scale) and a second group that is satisfied with the training opportunities (a score between 50 and 100 on the satisfaction-with-training scale). Figure 2 shows the effect of satisfaction with training opportunities on QWL, (i.e., job satisfaction, organizational involvement, and stress).

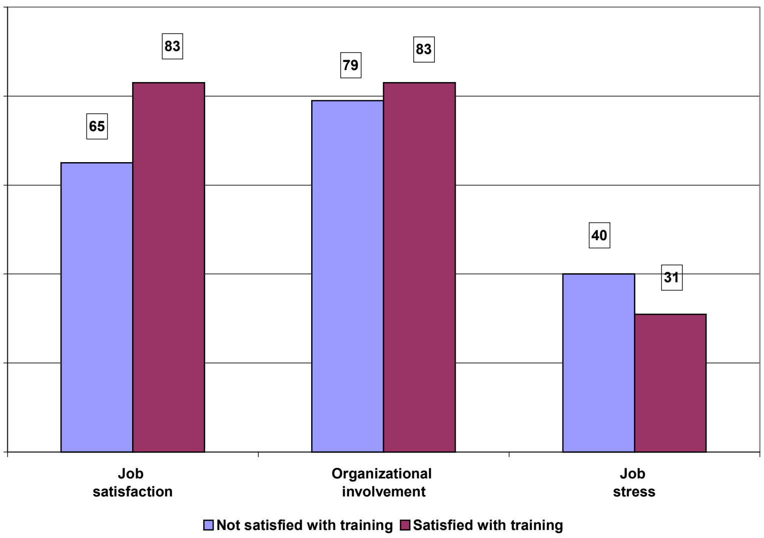
Obviously, satisfaction with training opportunities has an impact on QWL. Employees who are satisfied with training opportunities report significantly more job satisfaction and greater organizational involvement and suffer less from job stress than employees who are not satisfied with the training opportunities.

Furthermore, employees who are not satisfied with the training opportunities their organization offers are significantly more likely to look for another job (mean=3.07) than employees who are satisfied with the training opportunities (mean=2.13) (t-test, $p<.001$).

FUTURE TRENDS

Historically, women have had lower levels of educational attainment than men. However, in the past decade, this has changed dramatically. In general, more women have completed college, and more women have received bachelor's and master's degrees than men. Women still lag behind in science and engineering, although the percentage of women

Figure 2. Effects of satisfaction with training opportunities on QWL



in those fields is also increasing. Higher levels of educational attainment are associated with certain labor market outcomes, such as higher labor force participation rates, higher rates of employment, and higher earnings.

CONCLUSION

Results of this study show significant gender differences in the pathways to IT employment. Women have a higher general education as compared to men. Women have more often completed some graduate or professional study and/or have a graduate or professional degree. These results are different from the study by Igbaria et al (1997) who found that a larger percentage of female IT employees ended their formal education after attaining a bachelor's degree. The results are aligned with changes observed in the past decade, as reported by Freeman (2004), who found that more women have completed college, and more women have received bachelors' and masters' degrees than men. However, men completed *specific IT education* more often than women. Significantly more men in our sample have a university computer-related bachelor's degree as compared to women (24% vs. 13%). With regard to informal IT education, women (40%) received more often than men (25%) company-provided training and more often than men had their training through former work experience. Men, more often than women, had training for certification and were self-taught. With regard to on-going-training, results show that most employees (70%) receive company-sponsored training on company time. Female employees receive more company-sponsored training on company time than men. The average number of days of training is the same for men and women. Men have had more self-sponsored training than women, both on company time as well as on their own time. The majority of men and women are satisfied with opportunities for training. Half to two-thirds of the employees are satisfied with various aspects of training opportunities. They are most satisfied with training opportunities that were received *in the past* and that enabled them to do their job better. They are relatively less satisfied with training opportunities offered to them to keep up with latest technologies and training that enables them to do their job better *in the future*. On-going training and education are important in the IT work force. Results of this study highlight the variety of educational and training pathways and opportunities offered and used by IT workers. A few differences between men and women were found regarding some of the educational and training pathways and activities. But, overall, both groups of male and female IT workers report relatively high levels of satisfaction with training opportunities. Employees who are satisfied with training opportunities report higher levels of job satisfaction and organizational commitment, and lower levels of stress than employees who are not satisfied with training opportunities. Those satisfied with training opportunities are less likely to look for another job. Those results underscore the importance of the diversity of educational and training pathways for working in the IT. Once in the IT workforce, men and women report relatively high levels of satisfaction with training opportunities. Companies employing IT workers should pay attention to the variety of training opportunities offered to their IT workers, and ensure that those workers are satisfied with those opportunities. Dissatisfaction with training opportunities is related to a higher likelihood of looking for another job.

NOTE

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KEY TERMS

Education: Refers to the formal courses of study that one takes to obtain a formal degree.

Information Technology Work Force (ITWF): Information technology work force (ITWF) refers to the people who work in the information technology domain.

Job Satisfaction: Describes how content an individual is with their job. There are a variety of factors that can influence a person's level of job satisfaction; these factors include the level of pay and benefits, the perceived fairness of the promotion system within a company, the quality of the working conditions, leadership and social relationships, and the job itself (the variety of tasks involved, the interest and challenge the job generates, and the clarity of the job description/requirements).

Job Stress: Job stress is measured as burnout or the exhaustion of emotional and/or physical strength as a result of prolonged stress and/or frustration.

Organizational Involvement: The extent of an individual's involvement in an organization.

Quality of Working Life (QWL): Represents the quality of the relationship between employees and their total working environment, with human dimensions added to the usual technical and economic considerations.

Training: Training refers to the skills and knowledge taught to individuals within the information technology work force to make them proficient in their area of expertise.

Turnover Intention: The intention of an individual to move in or out of employment with a particular firm or organization.

Web-Based Survey: In the broad sense of the notion of a survey ("looking over or upon with a purpose of reporting the results"), any hypertext markup language (HTML) form that solicits input from respondents can be considered a survey. In our definition, a Web-based survey is a well-defined questionnaire, that has been proven to be reliable and valid in research and that, with the use of HTML, is put on the Web and solicits responses from specifically sampled respondents.

Gender Differences in Ethics Perceptions in Information Technology

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INTRODUCTION

Greater emphasis is now placed on ethics in information technology (IT) which covers a broad range of issues such as privacy, honesty, trustworthiness, software reliability, data storage, the environment, security breaches, hacking, viruses, and acknowledging the intellectual property of others. Further, legal aspects tend to overlap ethics perceptions. For example, issues such as copying computer programs, music CDs, images, or videos are more than just ethical problems; they also pose legal problems. The ethical dimensions also extend to issues such as computer crime and fraud, information theft, and unauthorized information dissemination.

These ethical issues are becoming more complex as continuing advances in IT present many new ethical situations and fresh dilemmas. Developments such as the Internet, electronic commerce, and wireless/mobile communications present a new set of ethical issues and challenge current of codes of ethics, copyright laws, and their authors. In addition, computer users' ethical standards may also vary from one situation to another (Wikipedia, 2005).

What is ethical is subjective, and more so in the areas of IT. Perceptions of ethics in IT vary to a degree from individual to individual. Further, there seems to be significant differences in the perception of ethics among males and females. According to Adam (2000), male and female judgment is most often influenced by their personal values and whether an action is considered legal. Woodcock (2002) conducted a study on ethical perceptions among 405 male and female students from universities, technical colleges, and schools in North-Eastern Australia and found significant differences in some ethical situations between males and females.

This article presents common issues and dilemmas that confront IT professionals, students, and the general community. In particular, it presents gender differences in perceptions of ethics and legalities in IT and highlights the different ethical perceptions of male and female students. These insights are particularly significant as the ethical beliefs and perceptions that students have may influence their ethical behaviors during their working careers.

BACKGROUND

The advent of the Internet and affordable computers led to a huge increase in computer users and computer usage. With the influx of many different users with varied qualifications and backgrounds, many types of serious ethical problems and issues confront IT professionals and users (Harris & Weaver, 1994), compounded by new behaviors and new forms of old behaviors facilitated by advances in technology (Adam, 1999). For example, the issue of intellectual property has taken on a completely new twist since the advent of the personal computer in the 1980s. As a result, stakeholders' perceptions and understanding of what is right, what is ethically right, and what is legal or illegal get blurred.

Ethics

Ethics, originally the domain of philosophers, deals with theories of morality and is broadly viewed as:

- Rules or standards of conduct or behaviour of a profession

- Morally right or correct behaviour, where morals are considered as standards of behavior; or conformity with accepted standards of conduct
- Qualities of honesty, truthfulness, and goodness

Thus, ethics tends to be defined by morals that are standards of behavior determined by society, with the additional qualities of rules of professional conduct, standards of a particular profession, and conscious principled decisions.

Ethics in IT

While computer ethics is defined by James Moor (1985) as "the analysis of the nature and social impact of computer technology and the corresponding formulation and justification of policies for the ethical use of such technology," its scope is quite broad. It also includes areas such as universal access, the environmental impact of computers, impact on employment, issues relating to the computer professional and personal impacts (Baase, 1997). It also provides ways of forming arguments and judgments on particular IT-based activities (Adam, 1999). Computer technology includes computer hardware, software, and networks connecting computers.

Other definitions of computer/IT ethical conduct are:

- "The application of ordinary business ethics to such computer related situation as copying software, obtaining access to certain software or data, and use of hardware" (Chaney & Simon, 1994, p. 19)
- Ethical standards in any environment that is computer-based (Forcht, 1991)
- Information technology ethics includes protection of information from electronic eavesdropping, monitoring e-mail, protection of property including software piracy, and unethical access by unauthorized reading, copying or making use of databases, programs, or other computer resources (Conger, Loch, & Helft, 1995)
- Information systems ethics is an issue that pervades thinking in all areas, from finance to database (Cohen & Cornwell, 1989)
- The three key areas that impact on ethical conduct are ethics, morality, and legality (Beauchamp & Bowie, 1988; Forcht, 1991).

There is also wide collection of codes of ethics from professional bodies and private and government organizations and they present rules and solutions to dilemmas that are present in computer ethics. The Computer Professionals for Social Responsibility organization (2005) further extends the scope of computer ethics. These include environmental issues and health hazards in production, use, and disposal of computers and associated hardware such as monitors and portable computing and communication devices.

DIMENSIONS OF ETHICS IN IT

Ethics in IT spans multiple dimensions. Woodcock (2002) studied the following seven key dimensions of ethics in IT that represent specific situations that often confront computing professionals.

1. Copying software also known as piracy
2. Breaking into computers commonly known as hacking
3. Violating intellectual property, copyright (plagiarism), and copying program code from a business
4. Privacy issues such as the use of private records
5. Personal use of business computers and/or software
6. Employer monitoring of computer usage and e-mails
7. Supplying computer programs with errors

Ethical Perceptions

Ethical perceptions are subjective and may vary to a degree from individual to individual and are often influenced by an individual's personal values and beliefs and whether one considers a particular action legal or illegal. Ethical perceptions and sensitivities of human beings seem to be shaped and molded from their formative years and subsequently influenced by their educational, work and social settings and experiences. There could also be cultural and regional influences.

Beside individual variations, there seems to be significant differences in the perceptions of ethics among males and females. To determine ethical and legal perceptions of male and female students, Woodcock (2002) conducted a study involving 405 students, who were all studying computing as all or part of their studies. The students were from senior high school (aged 16 to 19), colleges of advanced education (aged 16 to 50+), or universities (aged 17 to 50+).

The study contained 25 statements involving legal and ethical issues that were based on studies by Cohen and Cornwell (1989), Harris and Weaver (1994), Gregor and Whymark (1992), and Conger, Loch, and Helft (1995). To explore the influence of legal aspects on ethical perceptions, ethical as well as legal perceptions of the respondents of the survey were gathered for each of the statements in the survey.

The respondents of the survey rated their ethical perceptions on a 5-point scale that ranged from "highly unethical" through to "highly ethical", and legal perceptions on a 3-point scale, "illegal", "legal", or "unsure".

Table 1. Ethics perceptions of male and females showing significant differences

Ethical Dimension	Statement	Responses: Male Mean Score	Female Mean Score	Sig. difference between Male & Female*
1. COPYING SOFTWARE				
	Copying software for education use only	2.18	1.97	
	Copying software to evaluate for possible purchase	2.61	2.26	$p<0.10$
2. HACKING				
	Breaking into computer but not alter anything	1.88	1.49	$p<0.01$
	Breaking into computer and change information	0.97	0.92	
3. PLAGIARISM				
	Giving copy of work to another student to hand in	1.34	1.50	
	Using information from another source without recognition	1.39	1.38	
	Using information from the Web without recognition	1.63	1.50	
	Copying programs to use at another establishment	1.40	1.24	
	Copying programs then alter to sell to another	1.13	1.07	
4. PRIVACY				
	Selling data/information from establishment's records	0.92	0.97	
5. PERSONAL USE OF BUSINESS COMPUTERS/SOFTWARE				
	Using business computer to run own programs	2.13	1.81	$p<0.05$
	Using establishment's computer for private use	2.24	1.96	
	Using business computer for personal benefit	1.75	1.61	
	Using business software for assignments	2.59	2.54	
	Using business software for personal use	2.03	2.06	
	Playing games on computers at work in quiet periods	2.52	2.44	
6. EMPLOYER MONITORING				
	Employer monitoring computer usage without employee knowledge	1.32	1.48	
	Monitoring e-mail without employee's knowledge	1.11	1.34	$p<0.05$
	Monitoring e-mail with employee's knowledge	2.45	2.47	
7. SUPPLYING COMPUTER PROGRAMS WITH ERRORS				
	Handing-over program with errors–give no warning about errors	1.10	0.92	$p<0.10$
	Handing-over program with errors–warn the customer to save development & debugging time	2.22	1.93	
	Selling program with bugs to gain market share	1.12	0.85	$p<0.05$
	Selling program with bugs–not thoroughly tested	1.35	1.07	$p<0.01$
	Selling program with bugs–free fixes later	2.18	1.65	$p<0.01$
	Selling program with bugs– fix later for small charge	1.71	1.36	$p<0.01$

** Two-sided asymptotic significance of the chi-square statistic*

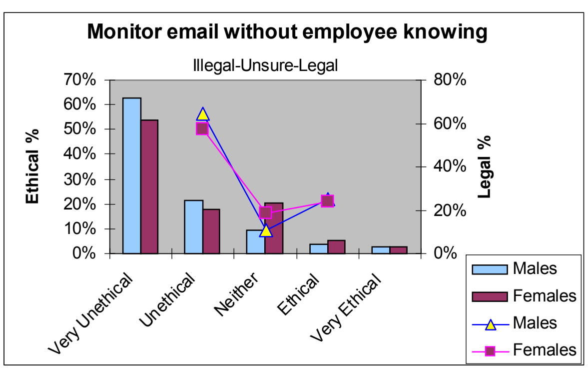
A summary of ethics perceptions of males and females which are based on the survey by Woodcock (2002) is presented in Table 1. The table shows the mean value of responses by gender, where the score of one represents "highly unethical" and five corresponds to "highly ethical". Cross tabulation analysis of the responses revealed that there were significant differences between the genders especially for 7 statements (whose the two-sided asymptotic significance of the chi-square statistic was $p<0.05$, shown in the last column of Table 1).

GENDER DIFFERENCES

The study found that females are more ethically sensitive than their male counterparts when presented with unethical scenarios. In most cases where the mean score in Table 1 indicates that the action in the statement is perceived to be unethical (score < 2.5), females tend to score these statements as being more unethical than males. This conclusion has also been made by Khazanchi (1995), Harris and Weaver (1994-95) and Kreie and Cronan (1998).

A significant exception to this finding is the case of an employer monitoring an employee's e-mail without warning or providing prior information to employees. There is a significant difference at $p<0.05$ between the genders, with males finding that this practice more unethical than females. This could indicate that females are more compliant with their employers, believing that they have the right to check on their employees. A study by Athey (1994) also showed that women tend to be more protective toward their employers by being more ethical than male programmers.

Figure 1. Employer monitoring employees' e-mail



As shown in Figure 1, a larger percentage of males than females perceive that employers monitoring of their e-mail without warning is also illegal. This shows a high correlation between legal and ethical perceptions—when an action is perceived as illegal it is more likely to be also perceived as unethical.

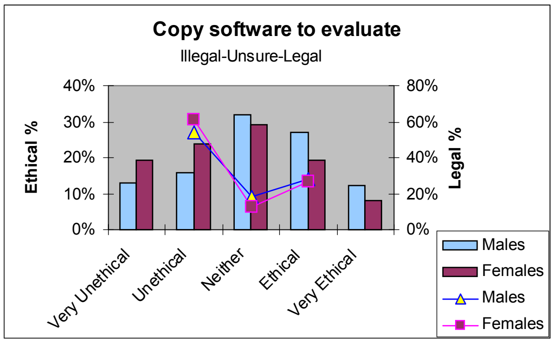
On the question of breaking into computers to test security without modifying or changing anything, commonly known as hacking, males would be more comfortable in this field of work. A greater percentage of females perceive this pastime as highly unethical and illegal.

The other area where the genders consistently disagree is on software development, especially with production of programs for clients and the selling of programs. Females perceive that handing over a program with errors, or known bugs, without telling the client, slightly more unethical than males. On the sale of programs with known errors, there is a highly significant difference at $p<0.01$ between male and female perceptions of the ethicality of that action.

In the highly topical area of selling programs that are known to have faults, students were provided with four scenarios: selling early to gain market share, selling without proper testing, selling but providing free patches later, and selling but providing patches at a small charge later. Both males and females perceived that selling programs with errors to gain market share was highly unethical but significantly more females responded this way. In the other three scenarios of selling programs with errors, there was a highly significant difference between the genders, with females consistently perceiving this practice more unethical than males. The perceptions of legality of these behaviors also varied among females and males, and this seems to have also influenced their perception on ethicality of these behaviors. Females have the perception that selling programs with errors is illegal and therefore tend to perceive this practice as unethical.

Lang (2003) notes that a strong mix of genders will enrich the IT discipline. However, with low participation rates of women in IT worldwide, there is a need to increase the number of female staff in production and sale of computer programs to provide

Figure 2. Copying software: Ethical and legal dilemma



them with the opportunity to influence and shape future applications of IT in industry and education. Lang (2003) also argues that there is a lack of diversity in the talent pool of people attracted to and entering IT, and that under-utilization of women results in a lack of the female perspective in IT applications.

ETHICAL AND LEGAL DILEMMAS

As highlighted earlier, there is interplay among ethicality and legality of certain issues or actions. In the case of copying software for personal use, 61% of female students and 54% of males perceived software copying for evaluation purposes as illegal yet only 43% of females and 28% of males perceived this as highly unethical or unethical (Figure 2). These tendencies were also noted by Harris and Weaver in their 1994-95 study.

Although the entire computer using population is exposed to this dilemma, it is students who are particularly prone to shifting their ethicality due to their lack of income and opportunity to purchase legal software. By calling their copy of software an evaluation copy, students are able to justify to themselves that what they are doing is ethically justifiable. This is an indicator to software manufacturers that providing evaluation copies of their software removes the guilt of doing something illegal and may encourage students to think of the company as an ethical company.

Studies by Khazanchi (1995), Harris and Weaver (1994-95), and Kreie and Cronan (1998) also showed significant differences between the genders for some of the ethical dilemmas presented to respondents though each researcher found that the differences between males and females occurred for different dilemmas.

Kreie and Cronan (1998, p. 76) concluded that men and women show a distinct difference in the assessment of what is ethical and unethical behavior. They also concluded that women were more conservative and tended to consider environmental cues as well as their own personal values.

The study by Woodcock (2002) highlighted here, shows that the study of Australian students concurs with the findings of others, that males tend to find most scenarios less unethical than females. However, the findings of this study need to be seen within the context of the study, which was targeted at students studying computing and did not include practitioners or those in workforce. Nevertheless it could be argued that these students when they enter into practice would carry the same ethical perceptions that will influence their work and practice. While short ethics statements used in the survey instrument allowed each respondent to interpret the statement in their own way, the study was extensive enough, involving 405 participants to subsume any misinterpretations.

FUTURE TRENDS

Issues in computer ethics will grow and change with the widespread adoption of new technology. Technologies such as RFID (radio frequency identification devices), mobile computing, and communication devices, SMS (Short Message Service), location monitoring and ubiquitous computing, and their business and personal applications pose several new ethical issues and challenges and they will need to be explored.

Further Studies

Ethics in IT needs further study involving IT developers and professionals, educators, business users, and general public. As the ethical perceptions of individuals may depend on their culture and socioeconomic conditions, a cross-cultural global study might provide further insights into this complex, inter-dependent phenomenon. There is also a need to explore gender differences in ethics perceptions between the open source community, business software developers, and the wider user community.

CONCLUSION

Ethical behavior seems to be a personal trait that does not appear to be affected by demographics alone and there is some diversity of perception among males and females. This diversity could, however, be better exploited by employers to ensure a balanced approach to ethical issues within the workplace. By including females on panels and projects, firms could ensure a commitment to an ethical approach to issues and concerns arising from information technology and its applications.

Females' perceptions of ethics are based on caring rather than an impartial reason (Adam, 1999). As she argues, taking feminist views and recommendations on computer ethics may offer fresh insights into addressing already recognized and new computer ethics problems that confront society.

It has long been discovered that the inclusion of females on decision-making panels adds a dimension of "care" to the process. The results of this study indicate that females do have what Adam (1999) calls an "ethic of care" and that the computing world may benefit by exploring the possibilities. The inclusion of females in at least the testing phase of program development seems to be an area where employers could see large improvements in the reliability of their programs.

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KEY TERMS

Bug: A fault, error, or glitch in a computer program or computer hardware. A term used since the 19th century to describe an industrial defect in machinery.

Computer Ethics: Social responsibility of individuals and organizations with regard to the use of computers, including hardware, software and communication networks. It also includes social responsibility in addressing environmental and health issues in production, use, and disposal of computers. It is an acceptable code of conduct of users, professionals, and organizations when using computers.

Computer Piracy: The unauthorized copying of original works including software, graphics, music or video for personal use or for profit.

Copyright: A form of protection provided by government laws to the authors of original works. In computing, original works can take the form of computer software, program listings, Web sites, graphics and images, photographs, audio, songs and video.

Ethicist: A philosopher who is versed in ethics. A person who has studied or written about ethics. A computing ethicist may prepare a code of computer ethics for organizations and computer users.

Ethics: Standards of behavior determined by society based on morals and/or rules of professional conduct.

Morals: Principles related to the rules of society. The conformity with generally accepted standards of behavior in conduct or character.

Perception: An intuitive recognition of a moral quality. The product of perceiving as against the act of perceiving.

Gender Differences in Information Technology Acceptance

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INTRODUCTION

Gender differences in computer use has been always a topic of research interest. The understanding of the patterns among gender, including beliefs, intention and use behavior of IT/IS would provide us a better picture to the process of design and implementation, which gives support to IT/IS success. However, published works explaining why and how beliefs and attitudes varied between different genders are still scarce, yet the topic was of widespread relevance.

We direct our empirical work on user's beliefs, intention and usage behavior. Gender differences in beliefs would likely make a corresponding impact on the intention to use or not to use computer in the future, and hence, the actual usage pattern. Assumed to be behavioral manifestations of users' gender differences, we infer these gender differences in the beliefs of computer use from their self-reported intention and usage behavior. Therefore, we aim to explore the factors affecting the intention and usage behavior; and their corresponding strengths in affecting the intention and usage behavior; in order to suggest effective implementation strategies accordingly.

The research questions of this empirical study are:

1. What are the emergent constructs that drive the intention and usage behavior of computer use?
2. Do users' beliefs regarding IT/IS usage differ among genders?
3. To what extent do these effects differ?

To address these research questions, we applied technology acceptance model (TAM) to a group of pre-service teachers, and measured their beliefs in using computer to explain the gender differences in their beliefs, intention, and usage of computer. The rest of the article proceeds as follows. The next section starts with a review on gender and technology. The third section explains the model framework TAM. The fourth section describes the instrument construction and validation. The fifth section reports the model testing results. The final section discusses the thrusts of the study and future trends.

BACKGROUND

There have been findings showing that gender differences in computer acceptance are prevailing. Young (2000) found significant gender differences in computer attitudes of 462 middle and high school students. The male domain scale showed that boys were more likely to have claimed computers as a male area. Thus, higher levels of confidence and, for males, the absence of negative teacher attitudes were associated with greater computer skills. Using TAM as the theoretical framework, Venkatesh & Morris (2000) found that, compared to women, men placed a greater emphasis on perceived usefulness in determining behavioral intention. On the other hand, women weighted perceived ease of use more strongly in determining behavioral intention than men did at earlier time frame. A few more empirical studies showed that gender differences in information technology do exist: Yuen and Ma (2002) found significant gender differences in beliefs while applying the technology acceptance model to a group of pre-service teachers; Houtz and Gupta (2001) found that males generally are more interested in information technology; Gattiker and Nelligan (1988) suggested that there is an association between gender and attitudes of information technology. On the other hand, interestingly, in their study of *Australian Women in IT*, Hellens and Nielsen (2001) indicated gender and IT were socially constructed as they suggested that cultural differences might be more important than gender alone, "Women of Asian background significantly outnumber all other ethnic female students in Australian IT degree studies" (p. 48). However, whether this applied to teachers is still in doubt and further empirical investigation was in need. Thus, the aim of this article was to explore gender differences in teacher computer acceptance in contrast to the studies in other workplaces. To prepare this article for the "Encyclopedia of Gender and Information Technology", part of the findings were extracted from a previous article of the authors (Yuen & Ma, 2002).

METHOD

Subjects

The study targeted pre-service teachers who were mostly fresh degree holders, joining the one-year full-time teacher education program (Postgraduate Certificate in Education) at a local university in Hong Kong. According to past experience, majority of these graduates would become teachers and work locally. It was believed that a study to these subjects would provide a good understanding of the pre-service teachers, but also shed light to understand the future computer use of in-service teachers. A summary of the 186 respondents who had successfully completed the survey instrument was listed as seen in Table 1.

Table 1. A summary of respondents details

Particulars	Composition
Gender	Male (24.9%)
	Female (75.1%)
Age	Less than 22 (9.8%)
	22-24 (68.5%)
	25-27 (12.5%)
	28-30 (2.7%)
	Over 30 (6.5%)
Full-time teaching experience	No teaching experience (87.5%)
	Less than 1 year (7.6%)
	1-2 year (3.8%)
	3-5 year (1.1%)
Major teaching areas	Art subjects (42.4%)
	Science subjects (35.5%)
	Social science subjects (22.1%)
Access to computers at home	Yes (98.4%)
	No (1.6%)
Formal computer training	Not at all (46.3%)
	1-8 hours (17.9%)
	9-16 hours (13.6%)
	17-24 hours (6.0%)
	25-32 hours (6.5%)
	33 or above (21.7%)

Technology Acceptance Model (TAM) and Its Measurement Items

In prior studies, there have been extensive investigations on developing computer attitude scale. Attitude was viewed in a hierarchical manner, including firstly the *affective responses to attitude*, then the *cognitive responses to attitude*, and the highest level of *conative responses to attitude* (Ajzen, 1988). Applying this attitudinal process to computer use, it might explain as: (1) firstly an user heard about computers and tried to evaluate them; (2) then, the user got chance to have hands-on experience with computers and formed perceptions about computers; and (3) finally, the user reflected his or her attitude on computers through behavioral intention and actual usage behavior. How to measure perceptions would become an important process to predict and explain computer use.

TAM was one of the widely validated and applicable model frameworks to measure perceptions on technology use. It was firstly suggested by Davis, Bagozzi, and Warshaw (1989). TAM suggested that perceived usefulness and perceived ease of use as two fundamental determinants to intention and technology usage. Other empirical tests of the TAM (e.g., Adams, Nelson, and Todd, 1992; Hu, Chau, Liu Sheng, & Tam, 1999) had for the most part, been supportive of the model for the last 20 years. Legris, Ingham, & Collerette (2003) conducted a critical review of the technology acceptance model and confirmed the wide applicability of the model towards a wide range of technologies, organizational contexts, and subject domains.

The use of TAM to investigate student-teachers' computer acceptance was advantageous because of its well-researched and validated measurement instrument. Specifically, the questionnaire was designed to include five items of perceived usefulness (PU1 to PU5), five items of perceived ease of use (PEOU1 to PEOU5), two items of intention to use

(ITU1 to ITU2). All items are measured in a 7-point Likert scale, with 1 indicating strongly disagree and 7 indicating strongly agree. The major measurement items were listed in the appendix. Subjects were also asked to report their self-reported usage. Duration of usage was measured in hours per week and was coded into seven categories, namely, "Less than or equal to 4 hours"; "4 to 6 hours"; " more than 6 to 9 hours"; "more than 9 to 12.5 hours"; "more than 12.5 to 16 hours"; "more than 16 to 20 hours"; and "over 20 hours". The degree of current usage of computer was measured in a 7-point Likert scale. At the same time, subjects were asked to state demographic data in the first part of the questionnaire, including gender, age range, major teaching areas, access to computer at home and if there was any previous formal computer training experience.

Procedure

Data were collected using a user-reported self-assessment approach. It deemed to be appropriate because of considerable literature support for its use in intention-based studies and being the common method used in TAM research (e.g., Collopy, 1996; Davis, 1989). At the beginning of the semester in October, a total of 282 questionnaires were distributed through the various group representatives. Subjects were asked to return the completed questionnaires to their group representatives within a week's time, just before they left for their school experience. Group representatives collected the questionnaires and sealed in an envelope and returned to the researcher for collection. 186 questionnaires were collected with return rate 66 percent.

FINDINGS

Summary of the Observed Variables and Scale Validation

The descriptive statistics of the measurement items were shown in Table 2. It showed that all the items showed generally positive perceptions towards computer use, all mean scores over four. The mean scores ranged from 4.60 to 5.79 while the standard deviations ranged from 1.15 to 1.51. All constructs satisfied the criteria of reliability (alpha > 0.80).

Table 2. Summary of descriptive analysis

	Mean	StdDev	Alpha	Factor Loadings
Perceived Usefulness (PU)				
PU1	5.19	1.23	0.88	0.81
PU2	4.92	1.33		0.73
PU3	5.21	1.25		0.89
PU4	5.19	1.30		0.83
PU5	5.37	1.25		0.66
Perceived Ease of Use (PEOU)				
PEOU1	4.72	1.33	0.86	0.88
PEOU2	4.60	1.29		0.85
PEOU3	4.99	1.15		0.83
PEOU4	4.75	1.22		0.78
PEOU5	5.04	1.51		0.57
Intention of Use (ITU)				
ITU1	5.79	1.17	0.85	0.87
ITU2	5.68	1.19		0.88

Discriminant validity was demonstrated if an item correlated more highly with items within the same factor than with items in a different factor (Campbell & Fiske, 1959). The inter-item Pearson correlation coefficients showed the discriminant validity where the coefficients of inter-item within each measurement construct were much higher than correlations across constructs. The factor components were then analyzed by a principal component factor analysis with varimax rotation method. The components generated confirmed the corresponding constructs as predicted by the TAM model. The EigenValues of the three components extracted were 5.436, 1.879, and 1.349 respectively. The percentages of variance explained by the components ranged from 11.245 to 45.302, with a total variance explained of 72.21%.

One-way ANOVA was employed to determine the mean differences between the different gender groups on the major variables (teaching experience, computer training, PU, PEOU, ITU, and Usage). No significant differences were found between gender groups for each variable.

LISREL Models

LISREL was a software product designed to estimate and test statistical models of linear relationships among latent and manifest variables. It was an extremely powerful structural equation modeling technique that had been used extensively in research (e.g., Hu et al., 1999). LISREL was then used to analyze the survey data and to perform the

Table 3. Summary of causal path analysis

Construct	Causal Path	Path coefficients Overall	Male	Female
PEOU	PEOU → PU	***0.58	***0.85	***0.47
	PEOU → ITU	0.15	0.07	*0.23
PU	PU → ITU	***0.43	0.33	***0.43
	PU → USAGE	***0.38	*0.31	***0.45
ITU	ITU → USAGE	***0.33	***0.61	*0.23
R^2		PU (0.33); ITU (0.29); USAGE (0.38)	PU (0.72); ITU (0.15); USAGE (0.61)	PU (0.22); ITU (0.33); USAGE (0.36)

Note: * p<0.05*;* ** p<0.01*;* *** p<0.001

analysis towards model testing. Table 3 showed the resulting model testing findings.

For the overall model, the data supported most of the individual causal paths postulated by TAM. Perceived usefulness had a significant direct positive effect on pre-service teacher's intention to computer use, with standard path coefficient 0.43 (p<0.001). Literally, this coefficient suggested that every unit increment in perceived usefulness would strengthen an individual's (positive) intention to computer use by 0.43 units. Perceived usefulness also had a direct and significant effect on usage, with standard path coefficient 0.38 (p<0.001). Effect of intention to computer use towards self-reported usage was significant and shown a 0.33 path coefficient. Thus, perceived usefulness had a direct effect, as well as an indirect effect, through the mediating intention to computer use, on usage. Perceived ease of use had positive effects on both perceived usefulness (path coefficient = 0.58) and intention to computer use (path coefficient = 0.15). Although it was a significant direct effect on perceived usefulness (t = 7.41, p<0.000), its effect on intention to computer use was statistically non-significant.

From the R square values, it showed that perceived ease of use explain 33% of the variance in perceived usefulness, while perceived ease of use and perceived usefulness together explained 29% of the variance in intention to computer use. Intention to computer use and perceived usefulness accounted for 38% of the variance in usage.

This finding was consistent with prior research (e.g., Venkatesh & Davis, 2000) that while "the effect of usefulness on usage was significant," "the effect of ease of use on usage, controlling for usefulness, was non-significant" with the reason that "ease of use operates through usefulness" (Davis, 1989, pp. 331-332).

The LISREL model was then analyzed on male as well as female data in order to examine the gender differences of the effect of each construct to the model. All data segments provided an overall fit of the model postulated by TAM. However, compared to women, men placed a greater emphasis on perceived ease of use in determining perceived usefulness (0.85 for male; 0.47 for female). On the other hand, women weighted perceived ease of use more strongly in determining intention to computer use than men did (0.07 for male; 0.23 for female). The causal path from perceived usefulness to intention to computer use was non-significant for men. For the case of women, the strong direct significant effect of perceived usefulness in determining intention to computer use showed that was hindered by the overall model, which was not consistent to prior research findings of Venkatesh and Morris (2000).

In agreement with what most literature postulates, the two independent variables, perceived usefulness and perceived ease of use, contributed significantly to the behavioral intention to computer acceptance and actual self-reported usage, accounted for 38%, 61% and 36% of the overall, male and female model respectively.

MAIN THRUST AND FUTURE TRENDS

Key Findings

The research questions of this empirical study were:

1. What were the emergent constructs that drive the intention and usage behavior of computer use?
2. Did users' beliefs regarding IT/IS usage differ among genders?
3. To what extent did these effects differ?

The empirical findings were that female and male users' differ in beliefs, intention, and usage. From the testing summary of the models, the beliefs were influenced and differed among different gender. Female users were influenced by both perceived usefulness and perceived ease of use to their intention and usage of computer, in a more balanced manner. Both factors were significant in predicting intention and usage, though perceived usefulness was stronger in effect ($ß=0.47$ at $p<0.001$ versus $ß=0.23$ at $p<0.05$). On the other hand, male users were nearly totally influenced by perceived usefulness to their intention and usage of computer. Perceived usefulness was significant and strong ($ß=0.85$ at $p<0.001$) while perceived ease of use was non-significant and had only an indirect effect through perceived usefulness toward intention and usage of computer.

Limitations of the Study

It was believed that the study on a longitudinal perspective would be conducted in order to gain better understanding about the users' acceptance behavior. Moreover, this study collected pre-service teachers' view on "computer" acceptance in a general term. This might also limit us from knowing the differences among other technologies or software applications. Therefore, further studies on the area of the acceptance towards different technologies and the acceptance differences on a continuous basis would also be recommended.

Contributions to Practice

This empirical study had unique contributions for IT/IS practitioners. Successful system implementation required users to effectively use the system while effective management required a better understanding of the beliefs of users toward IT/IS systems. The findings of gender differences in beliefs and their corresponding beliefs' strengths could assist in the proactive implementation planning of IT/IS (e.g., user training, system support, etc.) for minimizing the impacts while using IT/IS.

Contributions to Research

This study attempted to explore the teachers' computer acceptance and re-confirmed that perceived ease of use and perceived usefulness were the two independent variables towards computer use. It also revealed the gender differences in the application of the TAM. These findings were definitely important to the design of teachers' professional development. Viewing teacher training as a kind of remedy for teachers' inadequacy, teachers' computer training was, still in many cases, unified and one-off. Without a continuous development plan to teachers (e.g., Bradley, 1991), the problem of acceptance would still be an important barrier to the successful use of computers in education. The study had collected the views of pre-service teachers at a given point of time, however, studies found that the factors to pre-adoption and post-adoption might be different (e.g., Bhattacherjee, 2001; Karahanna, Straub, & Chervany, 1999), that was, a factor contributes positively to acceptance might not necessarily contribute to the same extent and degree after adoption. Sometimes, on the contrary, a factor might hinder further computer use.

CONCLUSION

In summary, this study extended the applicability of the technology acceptance model over teachers' computer use. It validated the instrument and the model framework using survey data from a group of pre-service teachers, as well as reflected gender differences in technology acceptance. We suggested that this model could be applied in the teachers' computer use context and used to explain the use intention and use behavior. We recommended that these findings to be included in future gender and IT/IS research studies.

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KEY TERMS

Affective Responses to Attitude: They are the responses that reflect evaluations of, and feelings toward the attitude object.

Attitude: An attitude is a disposition to respond favorably or unfavorably to an object, person, institution, or event.

Cognitive Responses to Attitude: They are the responses that reflect perceptions of, and information about, the attitude object.

Computer Attitude Scale: A composite instrument to measure an overall attitude of an user to respond favorably or unfavorably to computer.

Conative Responses to Attitude: They are responses that reflect behavioral inclinations, intentions, commitments, and actions with respect to the attitude object.

Perceived Ease of Use: The degree to which the prospective user expects the target system to be free of effort.

Perceived Usefulness: The prospective user's subjective probability that using a specific application system will increase his or her job performance within an organizational context.

Technology Acceptance Model (TAM): A model framework which is composed of two fundamental determinants, perceived usefulness and perceived ease of use, to explain computer usage behavior.

APPENDIX: MEASUREMENT ITEMS

Perceived Usefulness	
PU1	Using computer improves my job performance.
PU2	Computer enables me to accomplish tasks more quickly.
PU3	Using computer enhances my effectiveness on the job.
PU4	Using computer increases my productivity.
PU5	Overall, I find computer useful in my job.
Perceived Ease of Use	
PEOU1	Learning to operate computer is easy for me.
PEOU2	It is easy for me to become skillful in using computer.
PEOU3	Computer is flexible to interact with.
PEOU4	My interaction with computer is clear and understandable.
PEOU5	Overall, I find computer easy to use.
Intention to Use	
ITU1	I intend to use computer when it becomes available in my work place and at home.
ITU2	I intend to use computer in my job as often as possible.

Source: Adopted from Davis, 1989, p. 331

Gender Differences in Internet Usage and Task Preferences

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INTRODUCTION

How people use the Internet is an intriguing question to researchers, computer educators, Internet content providers (ICPs), and marketing practitioners. With the expansion of online information resources and the improvement of connection bandwidth, Internet users have been offered more and more choices, at the same time, faced with more and more dilemmas on how to allocate their time and energy online. How much time do people spend on surfing the Internet? What do they do? Are there any traceable patterns to interpret the Internet behavior and to predict future use based on people's demographic, social, or psychological characteristics? These are all interesting questions that researchers attempt to answer.

In 1995, the HomeNet project conducted at the Human Computer Interaction Institute, Carnegie Mellon University, launched a series of field studies to examine the residential Internet behavior. It has found that social demographics—generation, race and gender, rather than socioeconomic factors—income, education—and psychological factors—like social extraversion and attitude toward computing—were major influences on use (Kraut, Scherlis, Mukhopadhyay, Manning, & Kiesler, 1996). Following the HomeNet project's initial attempt, many empirical studies have been conducted globally to study the Internet behavior and its driving factors. Among these efforts, a noticeable focus is to resolve the long-lasting controversy, inherited from the similar debate of computer behavior studies, on how gender differences influence the way people use the Internet. Many researchers believe that females are less technology-inclined, less motivated, and therefore less competent in the masculine computer and Internet culture; on the other hand, some other researchers argue females have the ability to be proficient in use of the Internet.

The present study is thereby conducted to provide more empirical evidence of gender effects on Internet usage and task preferences. In particular, we are interested in examining gender influences when users' computer proficiency is controlled for. We believe that the results of this study can provide valuable insights into effective online content delivery, targeted marketing strategies, and customized computer education to encourage use. The close examination of people's actual surfing data can also contribute to a better understanding of how the Internet is actually utilized.

The next section describes the debate about how women and men respond in different ways to computers and the Internet. This is followed by a presentation of our study design: the monitoring software, the content classification schema and method, and the user population that we studied. The findings are presented next, followed by concluding remarks.

BACKGROUND

Research of gender influences on use of computers has generally shown diffused results. Many studies have found that males are more technologically inclined, more likely to perceive learning about computers is fun, more versatile in computer use, and have more confidence in computers than females (Krendl, Broihier, & Fleethood, 1989; Qureshi & Hoppel, 1995; Wilder, Mackie, & Cooper, 1985). Researchers have also found that women tend to use computers for work only, while men use computers for many other tasks (Condry & Keith, 1983, Gattiker, Gutek, & Berger, 1985), and females are more likely to experience techno stress in using PCs compared to males (Elder, Gardner, & Ruth, 1987). However, some other studies have shown evidence that females have the ability to be proficient in computing as their male peers (Turkle, 1995); when the level of experience is controlled for, males and females have similar level of interests in computers (Chen, 1986); and females are even more likely to think that computers are fun compared to males under certain circumstances (Kaplan, 1994).

Similar controversy continues on how gender differences impact the Internet behavior. Many researchers believe that the Internet has been male dominated since its inception: more males than females are using the Internet, males spend longer session online than females, and females lack intrinsic motivation to perceive the Internet as fun (Gackenbach & Ellerman, 1998). However, contradictory voices are also heard. The HomeNet study, along with many other studies, found that females tend to favor computer-mediated communication more than males: they perceive computer-mediated communication to be easier to use, more efficient and more effective than males (Allen, 1995; Kraut et al, 1996; Morahan-Martin & Schumacher 1997). It has also been shown that females use online social clubs and chat rooms more often (Tapscott, 1998); and they perceive certain Internet services more fun and use them more effectively, such as messaging facility, animation and multimedia feature (Teo & Lim, 1998).

The present study aims to examine the gender influences on Internet usage and task preferences in greater details. First, unlike the majority of the previous studies where Internet survey, interview and pencil-paper questionnaire are predominant methodologies of assessing Internet use, we developed a software program that records people's actual surfing activities. Second, we classify surfing activities into 17 categories, representing various information services and topics (such as e-mail, chatting, and online shopping). Such classification enables us to study gender influences on each of the major Internet components. Finally, our user population is gender and race balanced. Participants have similar social demographic characteristics, such as age, professional backgrounds, and computer proficiency, leaving gender and race the main sources of variation.

The effects of race, or country of origin, are also considered in the present study, because race is one of the most important Internet behavior determinants identified by the HomeNet study, and our user population is composed of multiple ethnic groups.

RESEARCH STUDY

The software program that records surfing activities was installed on participants' computers in early February, 2001. The participants were not informed when the program would be activated to monitor use. We selected three discrete weeks to collect surfing data for analyzing: the first week of March, the second week of April, and the first week of May, each representing a distinct school season that may influence use (in the middle of the semester, towards final exams, and the final week).

The Monitoring Software

We developed a monitoring software program to record both Web browsing and other Internet related activities, such as FTP file transfer, *Napster* music exchange, and use of *Microsoft Outlook* to write e-mails. The monitoring software also transfers the surfing logs to our central data repository automatically via Internet on daily basis.

The Content Classification Schema and Method

Our typology of the Internet mainly evolves from the classification scenario used by major search engines. We classify Internet activities, based on their functional areas or topics, into the following 17 categories: adult, chatting and messaging, e-mail (client-based), e-mail (Web-based), entertainment (gaming), entertainment (general), female-oriented, finance, FTP and file downloading, general information, health information, news, Usenet newsgroups, school-specific, search engines, shopping and auction, and technology-oriented. Note the Web browsing activities are classified at page level, for instance time spent on *Yahoo Mail* will be categorized as Web-based e-mail use, rather than use of search engines.

Two human coders were involved in classifying the usage data. We also developed software programs to assist in grouping similar items for easier classification and to automatically classify repeated activities. To assess the inter-reviewer reliability, a random subset of 350 surfing items was reviewed in duplicate. The raw agreement is 88.9% and the level of agreement beyond chance (*kappa*) is 87.7%. Researchers of this study also reviewed randomly selected datasets periodically to ensure the classification quality.

The User Population

Participants of this study were recruited from an IT-centric masters program at Carnegie Mellon University. Among the 57 students who responded to our advertisement, 45 were selected based on a pre-study survey. Usage data collected from 42 students were complete and valid. Three racial groups are present in our sample: American white, Chinese (mainland), and Indians. We filtered out groups such as American-born Chinese and American-born Indians to make sure that the "ethnicity" and "country of origin" are consistent. A personal laptop is a mandatory requirement for students enrolled in this masters program, and they do not have access to public clusters due to resource shortage. All participants also reported in the pre-study survey that they used their own laptops exclusively: no sharing with others, and no other computers to use.

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RESULTS

We first assess gender influences on overall usage of the Internet, followed by discussions of gender effects on each of the categories. Effects of race are then presented.

Overall Internet Usage

Male participants of this study used computers 6.8 hours on average per day, 2.6 hours of which were associated with Internet activities, while females spent 7.1 and 2.4 hours, respectively. The hypotheses that males spend more time are rejected (computer use: $F=0.1$, $p=0.75$; Internet use: $F=0.46$, $p=0.501$). This contradicts the findings of several previous studies that males spend significantly longer sessions on use of computers and Internet than females. One possible reason for this inconsistence is that the female respondents of those previous studies had different levels of computer proficiency compared with their male respondents. Diversity of age, race, educational and professional backgrounds further magnified the gap.

Computer-Mediated Communication

Previous studies have suggested that females are more favorable towards computer-mediated communication than males. However, we do not observe different usage patterns of using e-mail or chatting and messaging services. On average our

Table 1. Characteristics of user population

Number of participants	42
Age	Between 21 and 32
Gender	22 males and 20 females
Race	American white: 12, Indian: 15, Chinese (mainland): 15
Gender composition by race	American white: Male 6, Female 6 Indian: Male 9, Female 6 Chinese: Male 7, Female 8

Table 2. Categorized usage by gender group

Category	Male Average†	Male %	Female Average	Female %	ANOVA F Test for Allocation
1. Adult	40.7	1.35	20.7	0.55	3.52
2. Chatting and messaging	267.2	7.80	296.6	9.43	0.32
3. E-mail (client-based)	948.3	31.86	931.1	31.52	0.01
4. E-mail (Web-based)	92.5	2.51	44.0	1.41	2.57
5. Entertainment (gaming)	25.9	0.91	1.7	0.07	15.96***
6. Entertainment (general)	624	14.69	89	3.16	9.15**
7. Female-oriented	0	0	67.4	1.71	2.82
8. Finance	97.9	3.53	78.5	2.60	0.66
9. FTP and file downloading	30.1	1.14	23	0.68	1.16
10. General information	221.4	6.67	274.6	9.32	1.57
11. Health information	2.8	0.05	18.2	0.44	1.38
12. News	158.4	4.85	136.5	4.33	0.11
13. Newsgroups	27.1	0.76	12.6	0.42	0.6
14. School-specific activity	391.6	12.01	658.8	20.64	12.83***
15. Search engines	50.4	1.70	25.7	0.79	5.28*
16. Shopping and auction	58.8	1.74	130.1	4.44	3.46
17. Technology-oriented	247.4	8.43	263	8.49	0

† Average time (minutes) spent in three non-consecutive weeks.
* p<0.05; ** p<0.01; *** p<0.001

female participants spent 32.93% of their online time on reading and composing e-mail, slightly less than that of the male participants (34.37%). The hypothesis that females spend more time on e-mail is also rejected (F=0.26, p=0.612). Similar conclusion is reached for chatting and messaging (namely, use of tools such as *MSN Messenger* and *AOL Instant Message*). Females and males allocated 9.43% and 7.8% of their online time for chatting, respectively. The hypothesis that females use these tools more often is rejected (F=0.32, p=0.574).

We conclude that using the Internet for interpersonal communication is gender-neutral. Females exhibited greater enthusiasm towards computer-mediated communication in previous studies may be explained solely by its ease of use and the instant benefits a user can receive. Once females have acquired enough computer skills and accumulated sufficient exposure to other aspects of the Internet, computer-mediated communication is no longer the main motivation of future Internet use.

School-Specific Activities

The student participants might have to allocate significant portion of their time for school-specific activities. We find that female students spent 20.64% of their online time on reading school and course related content, while this usage only accounts for 12.01% for males. The difference is found to be significant (F=7.04, p=0.0114). Given the same level of overall Internet usage that we observed in previous analysis, this result indicates that the female participants use computers and the Internet less often for off-work activities. This finding is consistent with previous studies where researchers have shown that females tend to use computer and the Internet for work only, while males use them more versatilly.

Internet Entertainment

We first assess the gender differences in use of computers and the Internet for gaming. Female users rarely played games, while the males spent about half an hour per day on average on gaming related activities. The hypothesis that males spend more time on playing games is accepted at CI level of 0.001 (F=15.96, p=0.0003). This finding is consistent with many other computer and Internet behavior studies. It can be explained by the masculine characteristics such as more violence-oriented and tendency to conquer. In addition, most of the game titles available are tailored to male audience.

Besides gaming, there are other entertainment-oriented contents available on the Internet, such as movie reviews, music, and online novels. We find that females spent 3.16% of their online time viewing such content, while males spent 14.69%. The hypothesis that females and males allocate equal amount of time in this category is rejected at the CI level of 0.01 (F=10.85, p=0.0021). This shows that males are more likely to use computer and Internet recreationally than females. This finding also complements our previous finding (4.3) that females tend to use computers and the Internet only for work related activities.

Female-Oriented Content

This category refers to the Web sites that primarily target female users, such as fashion and feminine merchandise shopping sites. Female participants spent 1.71% of their online time for viewing female-oriented content; males rarely accessed such sites. Because browsing female-oriented content does not account for significant portion of female's online time, we argue that lack of female-oriented content may not be the primary reason that females will not perceive use of the Internet as fun.

Search Engines

Female participants utilized search engines less often than males. We find that females spent 0.79% of their online time on searching for new things, while males allocated 1.7%. The difference is also statistically significant (F=5.28, p=0.0269). This finding shows that females seem to be less self-motivated to look for new things on the Internet. The insufficient use of search engines might also lead to our female participants' significantly lower usage of various off-work activities.

Other Gender-Neutral Categories

Besides some of the categories discussed above where we find equal level of usage by gender, no significant gender differences are found in the following categories either: adult, finance, technology information, FTP and file downloading, general information, news, healthcare information, and shopping and auction. We argue that these categories are also gender-neutral: women and men exhibit similar interests and can use them equally effectively.

Race Effects

We find that race, or country of origin, only influences the use of real-time chatting and messaging. Generally Indian students tended to these tools more often (13.8% of total online time) than American white (5.87%) and Chinese (5.13%). Significant differences are also reported by ANOVA test (F=3.82, p=0.0307). This finding might be explained by race-related cultural influences, traditions, and structure of society, but the exact causality remains unclear without a comprehensive understanding of all ethnic groups involved. We further examined the effects of interactions of gender by race: none of the interactions is found to have significant impact on usage.

Other Findings

The HomeNet project reported that interpersonal communication, rather than broadcasting service, is the main motivation of Internet use (Kraut et al, 1996). In our field study these two types of usage account for 42.26% and 56.31% of all Internet activities, respectively. Amount of time spent on Web browsing is significantly higher than interpersonal communication services (F=28.48, p<0.001). We argue that interpersonal communication becomes a routine task once a user acquires enough skills and gains sufficient exposure to other aspects of the Internet. Browsing the Web has become the main motivation of using the Internet nowadays.

CONCLUSION

It has become common knowledge among Internet behavior researchers that age, gender, and race are three most important determinants of human behavior online. There is a controversy, however, on the question of how gender differences impact the way people use the Internet, and to what extent. This research provides more empirical evidence of gender influences on Internet usage and task preferences. We recorded and analyzed the Internet surfing activities of 42 graduate students enrolled in an IT-centric masters program at Carnegie Mellon University, for three discrete weeks each representing a distinct school season. The participants were chosen in a way that most of their social demographic characteristics, such as age, educational, and professional backgrounds, and computer proficiency are considered constant, leaving gender and race the main sources of variations.

Results of this study show that females can use the Internet equally well as their male peers. However, we find that females tend to use the Internet more for work-related activities. They rarely play games, and they are less likely to use the Internet for other recreation purposes. We further find that women use search engines less often, which may impair their ability to use the Internet more effectively and sufficiently. Effects of race do not seem to significantly impact Internet use.

Some of our findings contradict the findings from previous studies. For instance we do not observe distinct usage patterns by gender in use of computer-mediated communication, towards which previous research has reported that females exhibited more enthusiasm. We argue that with similar level of computer proficiency and professional backgrounds, females can perceive using other aspects of the Internet as fun, and can use them as effectively as their male peers. Our study also indicates that interpersonal communication is no longer the main motivation of Internet use. Web browsing is now driving today's Internet usage.

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KEY TERMS

ANOVA: Analysis of variance (ANOVA) is a collection of statistical models and their associated procedures which compare means by splitting the overall observed variance into different parts.

FTP: The File Transfer Protocol (FTP) is a software standard for transferring computer files between machines with widely different operating systems. It belongs to the application layer of the Internet protocol suite.

HomeNet: HomeNet is a research project at Carnegie Mellon University whose purpose is to understand people's use of the Internet at home (http://homenet.hcii.cs.cmu.edu/).

ICP: Service providers that create information, educational or entertainment content on the Internet.

Internet Surfing: All types of activities on the internet, such as writing and receiving e-mails, real-time chatting, and Web site browsing.

Microsoft Outlook: Microsoft Outlook is a personal information manager and e-mail client program from Microsoft, and is part of the Microsoft Office suite.

Napster: Napster is an online music service which was originally a file sharing service. Napster is the first widely-used peer-to-peer music sharing service, and it has made a major impact on how people, especially college students, use the Internet. Its technology allows music fans to easily share MP3 format song files with each other.

Usenet: A worldwide bulletin board system that can be accessed through the Internet or through many online services. The Usenet contains more than 14,000 forums, called newsgroups, that cover every imaginable interest group. It is used daily by millions of people around the world.

Gender Differences in IT Use in the U.S. and Japan

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INTRODUCTION

As information technology (IT) has become more common in everyday use, so too have concerns about the digital divide—unequal access to and use of IT across demographic groups and countries. Understanding the extent and causes of the digital divide is important because IT skills have become increasingly vital to individuals' economic success.

Although IT is widely available in both the United States and Japan, there are notable gender differences in its actual usage between the two countries. In the United States, the gender gap in IT use has narrowed over time, and according to some measures, women are at least as likely as men to use computers. In Japan, however, sizable gender gaps in IT use persist.

The contrasting patterns of IT use in the United States and Japan reflect differences in the structure of social organizations and institutions in the two countries. Studying gender differences in IT use across countries thus requires a nuanced understanding of the institutional context under which gender inequality is generated. Using the United States and Japan as contrasting examples, this article examines how gender differences in IT use evolve from gender inequality in broader cultural settings, particularly labor market institutions.

BACKGROUND

Gender inequality in the labor market is considerably greater in Japan than in the United States. Less than 50% of women in Japan are in the labor force vs. 60% in the United States. Japanese women are less likely to be employed in professional and technical positions than their U.S. counterparts; only 45% are professional or technical workers in Japan vs. 54% in the United States. The gender earnings gap is also more pronounced in Japan than in the United States; the female-to-male earnings ratio is 44% in Japan compared with 62% in the U.S. (International Labour Office, 2001). In addition, the proportion of women employed in nonstandard jobs—temporary, contingent, or part-time jobs that typically pay less and offer fewer fringe benefits than standard jobs (Kalleberg, Reskin, & Hudson, 2000)—is almost twice as high in Japan as in the U.S. (Houseman & Osawa, 2003; Nagase, 2003).

There are several reasons why the greater gender inequality in the Japanese labor market may lead to larger gender differences in IT use in Japan than in the United States. People who do not work do not have the opportunity to use a computer at work, which may result in lower overall computer usage. Because the gender gap in labor force participation is larger in Japan than in the United States, the gender gap in overall IT use may be bigger there as well. Further, differences in employment status may lead to differences in computer usage at other locations, such as at home, particularly if computer skills acquired at work carry over to other locations. Consistent with this, almost 70% of American adults who use a computer at work also use a computer at home, but only 31% of employed adults who do not use a computer at work do use one at home (NTIA, 2002). The cross-country differences in employment rates by sex suggest that gender differences in computer use overall and at home will be greater in Japan than in the United States. In addition, differences in the types of jobs held may lead to differences in computer use. Given their overrepresentation in nonstandard jobs, Japanese women may be more

Table 1. Computer ownership and internet use in the U.S. and Japan (Source: U.S.: National Telecommunications and Information Administration (http://www.ntia.doc.gov/) and Bureau of the Census (http://www.census.gov/); Japan: Economic and Social Research Institute (http://www.esri.cao.go.jp/))

Year	United States		Japan	
	Computer ownership	Internet use	Computer ownership	Internet use
1989	15.0	-	11.6	-
1993	22.8	-	11.9	-
1994	24.1	-	13.9	-
1996	-	-	17.3	-
1997	36.6	22.2	22.1	9.2
1998	42.1	32.7	25.2	13.4
1999	-	-	29.5	21.4
2000	51.0	44.4	38.6	37.1
2001	56.5	53.9	50.1	44.0
2002	56.5	59.1	57.2	54.5

Note: Computer ownership is the percentage of households that own a computer. Internet use is the percentage of individuals that use the Internet (from any location).

segregated into jobs that do not involve IT use than their U.S. counterparts.

OVERALL TRENDS IN IT USE

The proportion of households with computers was higher in the United States than in Japan as recently as the late 1990s. As shown in Table 1, the proportion of households with a computer was about 17% points higher in the United States than in Japan in 1998, for example. In fact, diffusion of computers in households in Japan remained lower than in most OECD countries throughout much of the 1990s (OECD, 2000). Only after the year 2000 did computer penetration rates in Japan reach a level comparable to the United States. Internet use in Japan also lagged behind the United States during the 1990s.

Several factors caused IT usage rates in Japan to lag behind the United States for many years. Higher costs of hardware and software and higher telecommunications fees contributed to the lower initial computer and Internet penetration rates in Japan (Economic Planning Agency, 2000). Over 90% of online content is in English (OECD, 2001) and computers predominately rely on the English language, but few Japanese speak English. Furthermore, although the typewriter was a common fixture in offices and homes in the pre-computer era in the U.S., no comparable counterpart to the typewriter existed in Japan. And because Japanese is still the dominant language used on computers in Japan, all users must first master the craft of transforming the English alphabet into Japanese characters (or *kanji*) using the conventional qwerty keyboard.

GENDER GAPS IN IT USE

In the United States, women are more likely to use computers at work than men. In 2001, as Table 2 indicates, almost 61% of employed women used a computer at work compared with less than one-half of employed men. This gap in favor of female workers has persisted since at least 1984, when the U.S. Bureau of Labor Statistics first began surveying individuals about computer use.

However, women's higher overall rate of usage of computers at work in the United States does not carry over to all aspects of IT access and use. Women are slightly less likely to live in a household with a computer (Losh, 2003), and men dominate household decisions about computer purchases (Papadakis, 2001). Some studies conclude that women are less likely to use the Internet at all (e.g., Bimber, 2000) and, conditional on Internet use, use the Internet less frequently (Ono & Zavodny, 2003).

Table 2. Computer use at work and anywhere in the United States by gender (Source: Bureau of the Census (http://www.census.gov/))

	Work		Anywhere	
Year	Men	Women	Men	Women
1984	21.2	29.0	17.3	19.4
1989	31.6	43.0	28.4	27.9
1993	52.4	40.3	36.2	35.8
1997	44.1	56.5	47.0	47.3
2001	48.2	60.7	59.3	60.2

Note: Percentage using a computer at work is among workers aged 18 and older only.

However, the gender gap in Internet use has diminished over time. Men were more likely than women to use the Internet in 1997, but the two sexes were about equally likely to be online by 2001.

While the gender gap in overall IT use has fallen over time in the United States, it has generally persisted in Japan. Despite overall improvements in IT access and use, women are significantly less likely to use computers than men in Japan at work or at any location (including at home). In 1998, for example, proprietary data from the Nomura Research Institute indicate that 37% of men used computers at work vs. 26% for women, and 42% of men used computers from any location compared to only 25% of women. These gaps did not narrow during the time period 1997 to 2001 (Ono & Zavodny, 2005). One area without a gender gap in Japan is computer ownership. Women are as likely as men to live in households with a computer (Ono & Zavodny, 2005). However, despite the equal access in the home, there is a sizeable gender gap when it comes to actual usage. Women are significantly less likely to use computers and the Internet even in households with a computer.

GENDER DIFFERENCES IN HUMAN CAPITAL AND WORK

Considering that, by 2000, Japan had caught up with the United States in terms of overall computer and Internet penetration, why do vast gender differences in IT usage still exist in Japan but not in the United States? One possibility is that the gender gap in IT use in Japan reflects patterns of differential investment in and accumulation of human capital between men and women.

Strong normative expectations for women to take on family responsibilities combined with the dual nature of the Japanese labor market adversely affect investment in Japanese women's human capital. Parents invest more in the human capital of their sons than of their daughters because the returns to men's education are higher. The differential investment in favor of sons over daughters contributes to the gender gap in advancement to higher education in Japan (Ono, 2004). Whereas women are more likely than men to be enrolled in university education in the United States, the opposite is true in Japan.

Japanese employers are also more likely to invest in the human capital of male workers than of females. Features of the so-called "lifetime employment system" such as employment security, extensive training, and internal promotion are only available to workers who can make a long-term commitment to a firm. Employers seek workers who will remain for a long period because this enables employers to recoup their investment in workers' training. These long-term employment relationships and internal labor markets disfavor women, who are more likely to exit the labor force upon marriage or childbearing. Employers engage in statistical discrimination, judging that women have a higher propensity to quit than men, and therefore prefer to hire men into career-track positions. Consequently, women are more likely to be employed in nonstandard positions that involve little training and few prospects for promotion. Despite a convergence in labor force participation rates between men and women, only a very small proportion of women enter career-track positions in Japan (Ono & Rebick, 2003). In addition, Japanese women are more likely than American women to quit their jobs following marriage or childbirth (Tokyo Metropolitan Government, 1994). If they re-enter the labor market later, many do so into nonstandard jobs because there are very few mid-career ports of entry back into career-track positions in Japan (Nagase, 2003).

The greater propensity for women to end up in nonstandard positions in Japan than in the U.S. may contribute to the cross-country differences in the gender gap in human capital accumulation. In the United States, about one third of female workers are in nonstandard jobs, compared with less than one fourth of male workers (Hudson, 1999). Japanese women are more likely to be employed in nonstandard jobs than their U.S. counterparts, with about 61% of female workers in Japan in nonstandard jobs compared with 22% of male workers (Ono & Zavodny, 2005).

Nonstandard jobs have several implications for human capital development. The temporary or part-time nature of the employment relationship may slow the accumulation of human capital. Because nonstandard workers typically have shorter employment durations with a firm, employers might invest less in training these workers because firms are less likely to recoup their investments. Temporary workers are therefore less likely to be employed in jobs that require large amounts of firm-specific training (Davis-Blake & Uzzi, 1993). Japanese employers do not provide as much training to women as to men because of concerns that women will get married and quit (Brinton, 1989), the same reason why they disproportionately hire women for nonstandard jobs.

GENDER, WORK, AND IT USAGE

The gender differences in human capital accumulation, likelihood of employment and types of jobs held in Japan may carry over to IT skills. Given that the cost of acquiring computer skills is not negligible in Japan, women may invest less in computer skills and subsequently be less likely to use a computer than men. A survey conducted in 2000 found that computer literacy was significantly lower among working women than among working men in the Tokyo metropolitan area (Recruit Works Institute, 2001). Women were less likely than men to use computer applications such as e-mail, Internet, and word processors and more likely to respond that they can barely use computers. The survey found that 42% of women work in positions that do not require computer use compared with 26% of men.

Gender differences in IT skills among workers are less pronounced in the United States than in Japan. Whereas men in Japan report more years of experience and better computer skills than women there, in the United States women report equal experience and better computer skills than men (Ono & Zavodny, 2005).

The relatively greater likelihood that women in Japan will be employed in nonstandard jobs than in the United States may contribute to the cross-country difference in the IT gender gap. Bureau of Labor Statistics data indicate that workers in nonstandard jobs are less likely to use a computer at work than workers in standard jobs, and this gap is larger for women. Data from the Nomura Research Institute show the same pattern for Japan. Although the magnitude of the gender gap in computer use between workers in standard and nonstandard jobs is similar across the two countries, a higher proportion of women are in nonstandard jobs in Japan than in the United States. This results in Japanese women being significantly less likely to use a computer at work than women in the United States. Ono and Zavodny (2005) show that the proportion of women who use a computer at work would rise by over one third in Japan if women there were employed in nonstandard jobs in the same proportion as men. In the United States, in contrast, employing women in nonstandard jobs in the same proportion as men would have a negligible impact on women's rate of computer use at work.

FUTURE TRENDS

There are few gender differences in IT use in the United States, and any such gaps have decreased in recent years. Indeed, women are actually more likely to use computers at work than men. In Japan, women lag behind men in virtually all measures of IT use, and these gaps have not narrowed appreciably over time.

The different patterns of men's and women's IT use in the United States and Japan parallel the differences in gender roles in the workforce. Although gender inequality in the labor market does exist in the United States, it is less pronounced than in Japan, where women lag substantially behind men in labor force participation, earnings and full-time regular employment. The disproportionate employment of Japanese women in nonstandard jobs—itself the consequence of normative expectations—appears to have resulted in their accumulating less human capital, including less computer skills. This gap in IT skills may be self-reinforcing, with women trapped in a cycle of having difficulty getting standard, permanent jobs because of their lack of experience with IT, and not acquiring IT skills because they don't hold jobs that provide or require IT training. The gender gap in IT use in Japan is unlikely to narrow absent changes in the fundamental labor market institutions and social organizations that give rise to gender inequality there.

CONCLUSION

As IT has become more common, the ability to use IT has become an important form of human capital that affects economic success. Studies have established a positive association between computer use and earnings, although the causal linkage is not clear (e.g., Card & DiNardo, 2002). Not having computer skills can lead to social exclusion as well as economic penalties (Haisken-DeNew & D'Ambrosio, 2003), making it important to identify groups that do not have access to IT. If women are significantly less likely to use IT than men, women may be at a social, political and economic disadvantage.

IT is widely used in both the United States and Japan, but there are notable differences between the two countries in the structure of labor market institutions and social organizations. The contrasting patterns of IT use between men and women in the two countries are better understood by closer examination of the gender differentiated patterns of human capital investments and labor force participation in these countries. Gender inequality in IT use therefore appears to arise from inequality at a broader societal level.

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KEY TERMS

Human Capital: Knowledge, skills, and abilities acquired by individuals via education, training, and experience that affect productivity and earnings.

Internal Labor Market: A labor market characterized by a limited number of ports of entry and exit, with most jobs filled via internal promotion or transfer, and by workers' compensation not being determined by competitive market forces.

***Kanji*:** Japanese alphabet system adopted and modified from Chinese characters. There are over 2000 *kanji* in general use. Software that enables *kanji* entry using the conventional qwerty keyboard was first developed in the early 1980s.

Labor Market Institutions: The set of formal constraints (e.g., laws and policies) and informal constraints (e.g., social norms and conventions) that influences the behavior of individuals and firms in the labor market.

Lifetime Employment: Also called permanent employment, lifetime employment refers to an employment system characterized by long-term employment relationships and low turnover.

Nonstandard Jobs: Temporary, contingent or part-time jobs. Nonstandard jobs usually pay less and offer fewer fringe benefits than standard jobs, which are full-time and permanent.

Statistical Discrimination: Differential treatment of individuals belonging to particular demographic groups based on statistical inferences of that group's past performance. Statistical discrimination in the labor market occurs when an employer uses observable characteristics, such as race or gender, to assign an approximate value of productivity to an individual based on the employer's previous experience with individuals with those characteristics.

Gender Differences in Online Courses

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INTRODUCTION

The effects of gender on learning outcomes of online courses depend upon general attitudes toward computers and computer usage, and particular perceptions of the online communication medium. The role of gender on use and attitudes toward computers has been studied thoroughly (Dyck & Smither, 1994; Gattiker & Hlavka, 1992; Whitely, 1997). There is also theoretical and empirical evidence suggesting that men and women conceptualize and use an online communication medium differently (Gefen & Straub, 1997; Herring, 1996). However, despite this body of work, the empirical evidence on the effects of these differences on learning perception and student achievement is mixed or inconclusive.

In a recent review of the literature on gender effects in online courses, Hiltz and Shea (2005) conclude that some studies document advantages for women because they participated more than men and/or achieved greater success in online courses (Moskal & Dziuban, 2001; Ory, Bullock, & Burnasa, 1997), while other studies found no significant differences by gender (Arbaugh, 2000a; Bourne, McMaster, Rieger, & Campbell, 1997). Empirical research based on multi-course samples also reports inconsistent findings regarding the effects of gender on learning outcomes. For example, while Arbaugh (2005) found a negative relationship between women and perceived learning in graduate level online courses, Fredericksen, Pickett, Pelz, Swan, and Shea (2000) found small but significant differences indicating that women perceived higher levels of learning in online courses when compared to men. In contrast, in a comparison among face-to-face, pure online, and hybrid courses, Benbunan-Fich and Hiltz (2002) report that women obtained higher grades regardless of the mode in which the course was delivered, but that learning perception was not affected by gender.

Since women and men differ in their preferred communication patterns, we believe that gender differences would emerge when we analyze online courses in terms of such patterns. Moreover, in order to understand such effects, researchers should take into account the instructional design of the courses in terms of how information is delivered through the medium and whether the students learn in isolation or in the context of collaborative exercises. The combination of the communication patterns that define the structure of online courses along with the gender-based preferences for these patterns will show whether there are gender differences in online courses and whether these differences affect learning outcomes.

This article offers a new perspective to examine the effects of gender on outcomes of online learning. We begin by briefly reviewing the literature in technology-mediated learning environments and previous gender studies and developing gender-related hypotheses for this study. Then, we describe the research methods and the sample. The data comes from post-course surveys of more than 500 students enrolled in forty MBA courses entirely delivered online. We follow with the presentation of the results and their discussion and present the future trends and conclusions in the last sections.

BACKGROUND

There are several research streams in online education, ranging from theoretical or conceptual models to prescribe how to use of technology in online courses (Benbunan-Fich, 2002; Leidner & Jarvenpaa, 1995) to empirical studies testing the effectiveness of different synchronous and asynchronous online learning environments (Alavi, Wheeler, & Valacich, 1995; Hiltz, 1994). As online course delivery has gained increased acceptance, the research focus has shifted from the comparison of online vs. traditional courses to contrasting pure online environments.

The key to draw meaningful distinctions among courses entirely delivered online is found in the combination of the instructional method and the learning model. Depending on the instructional method, there are at least two different ways to deliver content in an online environment: objectivism and constructivism. The direct-way or objectivist approach consists of delivering content in the form of lectures notes, or textual material that students assimilate independently. In contrast, the constructivist approach consists of providing access to multiple sources of information and/or databases where the students can construct their own knowledge.

With respect to learning models, there are also two different ways to promote student learning in online courses based on the expectations and requirements of participation. Students can learn the material on their own, working individually, or by working in groups. The combination of these approaches defines four types of learning environments: objectivist-individual, objectivist-group, constructivist-individual and constructivist-group. Each of these is characterized by fundamentally different communication patterns, which are expected to play a significant role in determining whether there will be gender-based differences in learning in the electronic classroom.

Previous studies of differences in communication patterns between men and women have found that men tend to communicate on the basis of social hierarchy and competition, whereas women tend to be more network-oriented and collaborative (Kilbourne & Weeks, 1997; Tannen, 1995). These findings on gender differences have been extended to electronic communication. Men communicate online in a competitive mode, either elevating their own status or lowering that of others, while women see cyberspace as a means to develop increased collaboration and support networks for learning and communication of the entire group (Brunner, 1991; Canada and Bruscha, 1991; Herring, 1996).

In a study about uses and perceptions of e-mail in the workplace, Gefen and Straub (1997) report that women perceived e-mail to have a higher social presence and to be more useful than men did, while men found e-mail to be easier to use. Women seek to build a cooperative context and use e-mail for context-building exchanges, whereas men focus more on the content of the messages.

The perceptions of computer conferencing facilities are consistent with those of e-mail. Men are more likely to consider computer conferencing as a place to send and receive information while women perceive it as a forum to pose questions and achieve consensus of understanding (Tannen, 1995). This suggests that men would find electronic communication easier to use for information dissemination, but more difficult to use for interaction with their peers (students or co-workers). Since men focus more on the content of the message, and prefer to use an electronic medium for information dissemination, courses based on the objectivist teaching model should favor men (Brunner, 1991). Thus,

H1: Men will achieve better learning outcomes than women in objectivist courses.

Unlike men, women prefer to use an electronic medium for consensus building and exchanges with peers. Another aspect of electronic communication that favors women is that the medium lets everyone speak equally, instead of one person dominating a conversation, which is more consistent with female discourse patterns (Strauss, 1996; Tannen, 1995). Moreover, the electronic medium also encourages women to express their ideas more openly and freely and provides more opportunity to think about their responses than traditional forums (Selfe & Meyer, 1991). Given these differences in how the genders perceive and use the medium (Gefen & Straub, 1997; Herring, 1996), an Internet-based course designed in a collaborative format should favor women. Therefore,

H2: Women will achieve better learning outcomes than men in collaborative online courses.

This study is focused on the relation between gender and particular teaching/learning models, as formulated in these two hypotheses. Many other

Figure 1. Research framework

		Learning Paradigm	
		Individual	Group
Instructional Method	Objectivist	Men (21)	Men (110)
		Women (15)	Women (80)
	Constructivist	Men (79)	Men (128)
		Women (49)	Women (93)

Note: Sample sizes shown in parentheses in each cell

predictions are possible based on the literature in this topic. However, they are beyond the scope of this article.

RESEARCH METHODS

These hypotheses were tested in a field experiment conducted at an upper-Midwest University in the U.S. The data comes from a sample of 40 MBA courses entirely delivered online from 2000-2002. The courses included several subject matters such as strategy, organizational behavior, project management, international business,human resources, finance, accounting, management information systems, and e-commerce. Enrollments ranged from 9 to 35 students per section. A total of 575 students completed a post-course questionnaire about the online course.

Fifteen faculty members taught the courses included in the sample. These instructors were interviewed to classify their sections in terms of the teaching and learning model. Their answers were validated with syllabus information and other course design indicators such as lecture notes, individual vs. group projects, and online discussions. Based on these interviews, four sections were classified as objectivist-individual, 14 sections were categorized as objectivist-group, nine sections were placed into the constructivist-individual and 13 sections were categorized as constructivist-group.

The research framework consists of a 2x2x2 factorial design crossing the instructional approach (objectivist vs. constructivist) with the learning paradigm (individual vs. groups) and with gender (See Figure 1). The dependent variables are perceived student learning and final grades. The perceived learning scale was originally developed by Hiltz (1994) and Alavi (1994), and adapted by Arbaugh (2000b). Table 1 presents the composition of this scale and the levels of reliability.

RESULTS

In order to analyze the role of gender on learning outcomes, hierarchical analyses of variance (Hanova) were conducted. These tests are recommended when the unit of analysis and the unit to which the treatment is applied are different. In this case, the unit of analysis is the individual student, but the treatment (online course) was applied to different groups of students (sections). Since the students are nested units within sections, the error terms are correlated and the assumption of independence of error terms required by traditional regression analysis is violated. For this reason, Hanovas are preferred over traditional Anovas (Raudenbush & Bryk, 2002).

Although the correlation between the two dependent variables (final grades and perception of learning) is relatively low (0.13), this correlation is significant at 1% because our sample is large (n=575). Since we are not interested in analyzing learning outcomes as a vector of responses and to simplify our analyses, we apply separate Hanova models to each dependent variable. In doing so, we

Table 1. Scale composition and reliability of learning perception

Items	Single Item Reliabilities
Good understanding of basic concepts	.93
Identified central issues in field	.93
Course quality compared favorably to other courses	.93
Improved ability to integrate facts	.93
Learned to see relationships between ideas	.93
Improved ability to communicate clearly	.93
Course served my needs well	.93
Satisfied with the course	.93
High quality class discussions	.94
Cronbach's Alpha (Composite Reliability)	**.94**

find that the there are no significant differences on final grades based on gender. Therefore, we cannot conclude whether the gender hypotheses are supported when grades are used as the dependent variable.

However, there are significant differences when learning perception is the dependent variable (model F=2.82; p<0.0001; R-square=30%). Table 2 presents these results. With the exception of instruction, which is significant at 5%, all the remaining single factors (collaboration and gender), two-way and three-way interactions and the nested factor (section) are significant at p<0.01. The significance of the nested factor indicates that there are important differences among the sections that explain differences in learning perceptions.

The significance of the three-way interaction among gender, instruction and collaboration implies that these factors in combination explain significant portions of the differences in learning perceptions. In particular, women in objectivist-individual courses report the lowest perceptions of learning across all conditions.

The first hypothesis predicted that men would achieve better learning outcomes than women in online courses whose instructional methods were based on the dissemination of information (objectivist), rather than on knowledge construction. The interaction between instructional method and gender is significant at 1% and, in objectivist courses the learning perceptions reported by men are higher than those reported by women (5.07 vs. 4.92). Thus, H1 is supported.

The interaction between collaboration and gender is also significant but the marginal means are not in the expected direction, as men report higher perceptions of learning than women in collaborative courses (5.04 vs. 4.98). It is noteworthy that the only case in which women report higher perceptions of learning than men is in objectivist-group sections. Therefore, H2, which predicted that women would achieve better learning outcomes than men in collaborative sections, is not supported.

Table 2. Means and results of learning perception

I. Cell Means				
	Individual		**Group**	
	Men	**Women**	**Men**	**Women**
Objectivist	4.90 (1.21)	2.77 (2.12)	5.11 (0.99)	5.33 (0.92)
Constructivist	4.61 (1.40)	4.65 (1.38)	4.98 (1.26)	4.68 (1.36)
II. Marginal Means by Category	**Men**		**Women**	
Objectivist	5.07 (1.03)		4.92 (1.50)	
Constructivist	4.84 (1.32)		4.67 (1.36)	
Individual	4.67 (1.36)		4.21 (1.76)	
Group	5.04 (1.14)		4.98 (1.22)	
III. Hanova Results				
	F-value		**p-value**	
Model	2.82		<.0001	
R-square	0.30			
Main Factors				
Instruction	5.41		0.02	
Collaboration	40.15		<.0001	
Gender	21.25		<.0001	
Interaction Factors				
Instruction X Collaboration	26.17		<.0001	
Instruction X Gender	6.54		0.01	
Collaboration X Gender	13.96		0.0002	
Instruction X Collaboration X Gender	25.68		<.0001	
Nested Factor				
Course-section	2.06		<.0001	

DISCUSSION

Although learning perception and grades are significantly correlated due to our large sample size, the low level of this correlation shows that these are distinct types of learning outcomes. In fact, our data does not show any significant gender differences for final grades, while it shows important variations for learning perceptions.

In the analysis of final grades, though there were differences by instruction methods and by learning models, gender as a factor was not significant. A possible explanation of this finding is that final grades combine individual performance in many different activities, with the personal effort made by each student to learn the material. Compensatory behavior in the form of additional effort to master the content is likely to neutralize any negative effects on the grades caused by a mismatch between the structure of the online course and the preferred gender-based communication patterns.

In contrast, the analysis of learning perception supports the first hypothesis. Men report higher perceptions of learning in courses where the instructional method is based on the dissemination of information (objectivist), when compared to other men in courses following constructivist approaches, and when compared to women in both methods. This finding is consistent with previous research reporting that in online environments, men focus more on the content of the messages and on the information delivered through the medium.

The second hypothesis, which predicted that women would achieve better learning outcomes in collaborative courses, is not supported by the data. Women report higher perceptions of learning than men only in collaborative courses following objectivist instructional methods. It seems that the learning advantages of matching women's preference for using an online medium for concurrence and cooperation with collaborative courses are lost when constructivist approaches are chosen as the instructional method. We attribute this finding to the difficulty of achieving consensus when constructing knowledge in an online environment. Nevertheless, women report the highest learning perceptions in objectivist-group courses (mean=5.33).

Several limitations must be considered when analyzing these results. First, this study took place in a particular university and within the MBA program. Therefore, these findings may not be reproduced in other contexts. Second, some factors could not be controlled because this is a field study as opposed to a laboratory experiment. However, despite these limitations, the fact that we obtain significant effects attests to the importance of gender differences.

FUTURE TRENDS

More research is needed to investigate how different instructional design decisions interact with gender-based preferences for online communication. Intriguing areas for future research endeavors are the relationship between objective and subjective learning measures and understanding why objectivist-group courses result in the best perceptions of learning for both genders. This study is one of the first steps in this direction.

CONCLUSION

Overall, the results suggest that the influence of gender in outcomes of online courses can be explained by examining the structure of the courses in terms of the desired communication patterns. These patterns are embedded in online courses through instructional methods (objectivist and constructivist) and learning models (individual vs. collaborative). Significant gender differences are observed in courses where there is consistency between gender based preferences and communication patterns. Men report higher perception of learning when instructional methods are based on the dissemination of information (objectivist) and women report higher perceptions of learning in collaborative courses, only if they are taught following objectivist approaches. Taken together, these results indicate that the best teaching/learning approach for both men and women in terms of learning perceptions is the group-objectivist category.

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KEY TERMS

Collaborative or Group Learning: A learning environment where students work together in small groups to solve a problem or complete a project.

Constructivism: A view of learning based on the premise that students construct their own understanding of the world around them in order to learn.

Hanova (Hierarchical Analysis of Variance): A statistical technique used to analyze the influence of one or more independent variables on individual level outcomes in situations where the individuals are part of a group when they experience the treatment.

Instructional Methods: Provision of cognitive processes or strategies necessary for learning but that students cannot or will not provide for themselves.

Learning Outcomes: Objective and subjective learning results achieved by students at the end of a course. Objective learning is typically measured by final grades, while subjective learning is gauged through the students' responses to a post-course questionnaire.

Objectivism: A pedagogical philosophy that views learning as a process of assimilating concepts or facts from an objective reality, independent from the learner.

Online Education: Use of the Internet and Information and Communication Technologies to deliver courses. This delivery usually takes place through a courseware environment (such as Blackboard) that provides secure access to course materials and discussion forums.

Gender Differences in the Navigation of Electronic Worlds

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INTRODUCTION

Recent developments in visualization techniques coupled with the widespread use of complex graphical interfaces, frequently designed to meet the needs of a perceived homogenous set of ideal users, have served to highlight the gap between what an interface demands of its user and the user's actual capabilities (Hindmarch & McDonald, 2006). Consequently, if we are to be able to develop more usable interfaces, then a consideration of individual differences in interaction becomes increasingly important. The most fundamental individual difference of all is that of gender, yet surprisingly it is often the most overlooked. In this article, it is argued that if we are to develop more usable interfaces then individual differences such as gender are not factors that may be considered in the design process, but factors that must be considered. The issue of navigation in virtual and information spaces will be used as a vehicle for this discussion.

THE IMPORTANCE OF NAVIGATION

Navigation is a complex process, which involves determining and following a path through an environment to reach some goal or target. In the physical or virtual world, this might be to arrive at a particular place; in information worlds, this goal may be to find a particular Web page or unit of information. In recent years, navigation has become a key issue within human computer interaction (HCI) research. It has also been the focus of much research in the field of individual differences, meaning that it is one of the few areas in which there is a good corpus of work on gender-based differences in interaction. In addition to providing a forum for this discussion of gender differences on a key interaction task, navigation also provides an example of how performance differences in interaction may be an artifact of the metrics used to study a particular behaviour. The next section of this article presents the results of research studies that have investigated gender differences in navigation. The implications of this work are discussed and areas of future research are highlighted.

IMPACT OF GENDER ON NAVIGATION

A number of studies of way-finding in the physical world have demonstrated gender-based differences in terms of navigational efficiency (usually assessed by task completion times), and navigational strategy (for example, Lawton, Charleston and Zieles, 1996). The results of such studies usually end up being reported in the popular press as evidence that males are generally superior at this type of activity than females. This may serve to strengthen the stereotypical view that some careers that might draw upon this skill would be unsuitable or in some way inappropriate for women, and in so doing increasing the possibility that some women may feel discouraged to engage in these areas. These studies have also impacted on the study of navigation in virtual worlds as it is assumed that there is a direct parallel between the development of navigation knowledge in real and virtual worlds (Kim & Hirtle, 1995).

The findings of studies of gender differences in virtual worlds do seem to support the general trend that has emerged from studies of physical spaces. The general pattern of results suggest that females tend to rely much more heavily on landmark knowledge than males, who can use landmark knowledge but are more adapt at using other environmental cues. For example, Devlin and Bernstein (1995) found that males made fewer errors and were better able to use visual-spatial cues than females in a computer simulation of a real environment. Schmitz (1997) found that girls relied upon salient landmarks within a maze to guide their navigation to a greater extent than boys. Similarly, Sandstrom, Kaufman, and Huettel (1998) and Dabbs, Chang, Strong, and Milun (1998) also found that females tend to rely predominantly on landmark information whereas males use both landmark and geometric information equally well. Previous research has also shown that females are more likely than males to refer to landmarks when asked to give directions (Miller & Santoni, 1986), and are more accurate at recalling landmarks than men (Galea & Kimura 1993). Cutmore, Hine, Maberly, Langford, and Hawgood (2000) suggest that while both males and females make good use of landmarks as navigational cues, males tended to do so with greater efficiency. They studied navigation through a virtual maze and found that male subjects were able to find their way out of the maze with fewer moves than female subjects. Cutmore et al. (2000) found that subjects' navigation of the maze improved over a series of trials suggesting that subjects were forming a mental representation of the environment, however male subjects reached a more optimum level of performance in the maze before female subjects.

The reliance upon landmarks demonstrated by female participants in these studies is of particular interest since landmark knowledge is thought to represent the primary stage of spatial knowledge acquisition in a new environment. According to Siegal and White (1975), the development of spatial knowledge of a new environment progresses through three levels of representation. Initially landmarks are recognized and are used to guide subsequent navigation. Landmark knowledge is followed by the development of route knowledge, which is characterized by the ability to navigate from one point in the environment to another, using existing knowledge of landmarks to guide decisions concerning when to take right or left turns. The final level of representation is survey knowledge. Survey knowledge allows us to give directions to others, traverse unfamiliar routes, and know the general direction of places. As such, survey knowledge is based upon a global frame of reference. This level of representation is often referred to as a cognitive map. Hence the implications of studies that have found gender differences suggest that females take longer to acquire spatial knowledge than males. However, they do not tell us about the quality of the representation once it is fully formed. It may be that while it takes longer for women to acquire this knowledge their resulting representation is much richer, as yet this has not been examined in the research literature. Moreover, it is unclear as to the extent that the environments used in these studies will have affected performance. The complex and often unrealistic environments used may only serve to heighten differences in performance.

It has been suggested that the parallel between spatial knowledge acquisition in real and virtual worlds may also extend to hypertext systems. While the results of some early studies suggest that this parallel might actual hold (Kim & Hirtle, 1995), the issue of gender differences in this domain has not been considered in much detail. McDonald and Spencer (2000) conducted a small preliminary investigation into gender-related differences in Web navigation. The study focused on the three areas in which gender differences have been previously found, user confidence, navigational efficiency, and navigational strategy. The study employed a variety of behavioural and self-report measures including rating scales for user confidence measures, and unobtrusive monitoring of the users' movements and verbal protocols. Participants were required to complete a number of search tasks and a direction giving task. Participants were asked to direct a co-experimenter to a specified area within the Web site. McDonald and Spencer found that while there were no differences in efficiency on the search task, female subjects indicated they were less confident about their ability to complete the tasks than males. In terms of verbal data, female subjects made more references to landmarks in the direction giving task than male subjects. They also tended to engage in more analysis of where a particular link might take them. In addition, female subjects were less confident about their ability to complete search tasks than male subjects.

It seems unlikely that the results obtained in these studies are due simply to differences in the rate at which males and females acquire knowledge. Navigation is a complex interactive process, which involves both the execution of actions and the evaluation of system changes; therefore it is unlikely that one single factor will have an over-arching effect. Indeed, it seems that from the McDonald and Spencer study that confidence was an issue that may well have affected performance. Confidence was also found to be an issue for some of the studies on the navigation of virtual worlds, with male participants expressing a greater degree of confidence than females (Devlin & Bernstein, 1995, Schmitz, 1997). However, it may be that females' poor confidence ratings may also reflect a general tendency of women to underestimate or belittle their performance of tasks that are gender typed as masculine (Beyer, 1990). For example, Beyer found that female confidence estimates were affected not only by their actual performance on masculine typed tasks but also by their own low expectations of their performance. According to Lawton et al. (1996) environmental way-finding is stereotyped as a masculine activity. This factor may well account for differences in confidence expressed, and it is likely that confidence may well affect search times.

IMPLICATIONS FOR DESIGN

The studies discussed in this article have implications for both system design and also research studies that seek to examine the impact of individual differences such as gender on navigation. The findings suggest that parallels do exist between navigation in the real world and navigation in virtual worlds, and that gender differences are apparent in the strategies used by males and females. Therefore, as worlds grow in size, complexity, and use, there is a greater need to provide integrated support for these different strategies so that neither gender group is put at a disadvantage. While there is no evidence regarding the ultimate quality of the mental representations male and females develop through navigational experience in an environment there is evidence to suggest that males may progress to survey knowledge faster than females. The primary areas of application of such worlds are in the areas of leisure and education. Games based on the exploration of virtual worlds are frequently used in the context of both home entertainment but also for educational purposes, a large number of which require users to navigate in a range of environments. In order to support the navigational strategies of both males and females it is essential that these environments include cues that appeal to both types of strategy. For example, an environment free of landmarks may well prove to be disadvantageous to female users. In addition, the time allowed to navigate between different sequences may also need to be extended to accommodate for the differences in the rate of spatial knowledge acquisition. Moreover, as confidence in use appears to be an issue for females there is a need for the designers of such software to ensure that their products appeal to both genders. In terms of interface options this might be achieved through the provision of extended choice in terms of character selection, environmental situations, and storylines. However, for this to happen designers must avoid the pitfall of grounding themselves in their designs that is designing for themselves rather than for the intended end users. As Ahuja (2002) points out much educational software is written for boys' interests rather than girls' interests.

An example of where a consideration of gender differences in design has led to improvements in interaction can be found in the work of Tan, Robertson, and Czerwinski (2001) and Czerwinski, Tan, and Robertson (2002). Tan, Robertson, and Czerwinski (2001) found that male subjects were able to complete navigation tasks in a virtual world faster than female subjects when both were using small displays, however, this difference was eliminated when a larger display was used. Czerwinski et al. (2002) examined this difference further and examined the effects of providing a wider field of view on a large display they found that the use of this display brought the performance of female users up to the level of male users. The male users were also able to successfully navigate using this display and it had no ill-effects on their performance. Czerwinski et al. (2002) suggest that the wider display helps female subjects because it enables them to perceive more information through visual scanning which has the effect of facilitating the construction of a cognitive map of the information structure.

RESEARCH IMPLICATIONS

The McDonald and Spencer (2000) study suggested that females engage in more analysis of where a particular link might take them when performing their direction giving task. This behaviour may have implications for how we might measure navigation performance. Within HCI studies the most commonly used experimental metrics are time on task and the number of errors made. Clearly, if females are engaging in this type of analysis then they may also be more likely to take longer completing the task, as a consequence measures based on time may highlight differences in efficiency, which are not actually there. Moreover, an important aspect of Web navigation is link elimination. Users must match their information goals against the link categories available and select the most appropriate link to follow. It seemed that the female subjects in the McDonald and Spencer study were engaging with this process more readily than the male subjects who were more apt to follow the closest match link. Measures of the navigator's path and the method by which a navigator arrives at the task destination appear to be a more fair way of assessing differences. If enough data is collected on path measures it may indeed be possible to infer a degree of user confidence from independent measures alone as proposed by Smith (1996). However, such independent measures need also to be supported by self-report data such as those derived from verbal protocols which provide an insight into the strategies that underlie observable behaviour. Navigation is a cognitively demanding process that involves moving oneself sequentially around an environment deciding at each step where to go next. The thinking behind those decisions may indeed be more informative than an observation of the subjects' chosen path. This is very important in the case of Web navigation where navigational errors may result from link label ambiguities rather than the user's ability to navigate per se.

The consideration of gender as a factor within HCI has received relatively little attention, despite the fact that there are frequent widespread differences in performance of subjects within research-based studies. Studies of gender differences in navigation in electronic worlds are surprisingly thin on the ground despite the fact that differences have long been demonstrated in real world studies. Researchers' failure to acknowledge the gender factor serves only to limit the validity of their work, yet in many important areas of study within HCI researchers do not strive to ensure an equal gender split among their subject base even in areas where there is known evidence that gender differences exist. For example, there are a large number of reports that spatial ability is positively correlated with navigation performance in hypertext systems, a finding that was confirmed by Chen and Rada's (1996) meta analysis of twenty three individual studies in the field. Probably the most frequently cited study in this area is Vincente and Williges (1988). Vincente and Williges found that users demonstrated enhanced search performance using a graphical interface than a text-based interface. They also found that users with high spatial ability were able to complete search tasks more quickly than users with low spatial ability in a graphical computer interface. However, only seven out of the forty subjects in their study were female despite the fact that there is a wealth of evidence for the existence of gender differences in spatial abilities, with males demonstrating distinct advantages in spatial tasks over female subjects (Galea & Kimura, 1993).

CONCLUSION AND FUTURE WORK

While the general pattern of findings of the work discussed here suggests that gender differences in the navigation of virtual worlds parallel those existing in physical spaces there is still much research to be done. Studies are needed to examine the impact of world complexity on navigation performance over a number of interaction periods so that differences in spatial knowledge acquisition can be studied more closely. Only that way will we be able to examine differences in the ultimate quality of male and female cognitive maps. Studies are also needed to examine the type and placement of landmarks in virtual worlds to understand if they can actually lead to improvements in navigation performance of female users.

The study of individual differences in human computer interaction is growing in importance. The widespread use of computers dictates that designers can no longer assume that all computer users fit an ideal homogenous profile of skills, knowledge, and abilities. Improving the usability of computers through graphical user interfaces is a laudable aim, yet if that interface is designed on principles that meet the needs of only half of the population failure is inevitable. The importance of individual differences such as gender must also be considered within the context of the research laboratory to ensure that we are not designing experimental protocols and metrics that disadvantage particular user groups, to do so would serve to perpetuate the digital divide.

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KEY TERMS

Cognitive Map: The mental representation an individual holds of an environment which is used to guide navigational choice and also for route planning.

Human Computer Interaction: An interdisciplinary subject linking computer science with many other fields to study the interaction between people (users) and computers.

Hypertext: A collection of information-based documents (e.g. Web pages) that are linked together via referential links to form a navigable structure.

Navigation: A process which involves determining and following a path through an environment to reach some goal or target.

Spatial Ability: Cognitive skills related to visualization, the ability to construct and manipulate a mental image of an object, and the ability to determine the location of objects.

Spatial Knowledge: The knowledge an individual holds about the structure of an environment. This knowledge is thought to develop through three stages, landmark , route and survey knowledge.

Virtual World: An immersive or non-immersive display environment that depicts realistic scenes.

Gender Discrepancies through the College Years

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INTRODUCTION

Women made significant contributions to the beginning of the computing revolution. For example, Ada Byron Lovelace helped write the first subroutine, the women of the ENIAC age programmed the first computer during World War II, and Admiral Grace Hopper wrote the first compiler. While there have been female pioneers in the field, today men dominate the world of information technology (Riemenschneider, Armstrong, Allen, & Reid, 2004). Gürer and Camp (2002) report that many science fields hold women in low esteem, and attempt to reject them. Moreover, women are actually declining as part of the technology workforce: they made up 41% of the information technology workforce in 1996, but in 2002 that proportion was down to 35% (Cockburn, 1999). Furthermore, the number of female university students currently studying information technology and computer science will not lead to an increase of females in the profession: in 2002, only 28% of all degrees in computer and information sciences went to women (NCES, 2003); in 2003, only 19% of computer science students were female (Wilson, 2003) and only 28% of the undergraduate students in information science were female (Saye & Wisser, 2004). In a time where women make up the majority of university students (NCES, 2003), why is information technology seeing the opposite trend (Zeldin & Pajares, 2000)?

There are a number of theories as to why so few women have chosen to pursue a career in technology (Acker, Barry, & Esseveld, 1990; Cooper & Robinson, 1985; Wilson, 2003; Zeldin & Pajares, 2000). Furthermore, nearly all studies on the subject have been done in the United States (Irani, 2004; Lips, 2004; Wilson, 2003) while only one study cited here explored the gender gap among university students at the University of Hong Kong (Huang, Ring, Toich, & Torres, 1998). A number of feminist researchers believe that science (including technology) has a language that is masculine in nature (Acker et al., 1990). Furthermore, since our society understands gender as binary—that is, what is masculine is not feminine and vice versa—the very nature of science leaves women out. Once women get into the IT world, they face issues of personality and confidence that differ by gender.

One theory, to be explored in depth here, is that women enrolled in introductory programming courses have less confidence in themselves than do their male counterparts and that the confidence level of female students decreases significantly between secondary and post-secondary education (Lips, 2004). In addition to being shaped by their comparisons of their performance with the performance of their male peers, women's self-confidence is likely influenced by their experience of stress in their technology-oriented courses. These influences, combined with inaccurate views of IT careers, are influential in whether or not college students decide to work towards an IT-related major or choose another discipline all together (Irani, 2004; Zeldin & Pajares, 2000).

BACKGROUND

Self-perceived abilities in a given task affect performance capabilities, choices, and effort towards that activity (Zeldin & Pajares, 2000). One's self confidence, therefore, directly affects one's choice of a field of study or a career. This self-confidence, termed self-efficacy by Bandura (1986, 1997), is derived mostly from outside sources rather than the individual. In his social learning theory, Bandura (1997) posits that the most important source of influence on one's self-efficacy comes from "mastery experiences" or one's past accomplishments at a given task or in a given area of study. The second source, and of more concern for the current discussion, is the way one perceives others performing the same task. For young women in introductory technology and programming courses, seeing their male peers as supposedly outperforming them can be quite daunting. This intellectual threat can be compared to stereotype threat, which is the idea that minorities (in this case, women) must prove themselves in order to ameliorate the stereotyped expectations of others (Steele, 1997). To overcome this threat, women must do more than men in order to be viewed as a success by society. A third source of influence on self-efficacy is verbal feedback (Bandura, 1997): positive reinforcements raise an individual's confidence levels. Finally, there is the physical and emotional condition of the individual—particularly when it comes to the effects of stress and tension. Stress and tension can lead one to feelings of failure (Zeldin & Pajares, 2000). With so many external and internal forces affecting women's self-efficacy beliefs in the male-dominated world of information technology, it is easy to see why some would choose alternatives to a technology-oriented profession.

Zeldin and Pajares (2000) critiqued Bandura's beliefs in relation to women entering male-dominated fields. They interviewed college-level mathematics students to discuss the influence that internal and external forces had on their decision to stay in the field. While Bandura argued that parents, teachers, and peers have a great influence on choices and perceived abilities, Zeldin and Pajares found that significant others (boyfriends, fiancées, husbands, life partners, etc.) for women in male-dominated fields are the most important influences for self-efficacy beliefs (Zeldin & Pajares, 2000). They concluded that not only skill-based, but both academic and relational self-efficacy beliefs caused these women to succeed.

In relation to technology, Wilson (2003) found that fewer females than males concluded that they were proficient with computers—and she studied only computer science students (Wilson, 2003). Also, more females in Wilson's study agreed that "Computers make me feel nervous." Females' low self confidence, compared with their male counterparts in technology, supports Bandura's (1986, 1997) theory that seeing how others perform at the same task and comparing one's performance to theirs can influence one's self confidence. This finding is also consistent with interview results from Irani's study (2004). She quotes one of her participants, a female: "I have friends (that are male) who are like 'that program is so easy ...' but I know they spent a lot of time on it" (p. 197). For females in the course who do not know that the males spend a significant amount of time on a program, hearing the males' comments can be quite discouraging.

Another factor that affects women's self-perceived abilities is personality. Cooper and Robinson (1985) found that female freshman orientation students who enter male-dominated fields have characteristics very similar to those of the stereotypical male. In particular, women in male-dominated fields are similar to men in *motivation* traits (Chusmir, 1983). These characteristics relate to achievement and include: controlling, assertive, angry, and self-critical (Cooper & Robinson, 1985). These traits are what the researchers believe give women and men in both scientific and technological fields the confidence necessary to succeed in a stressful world.

Stress is another factor related to women in male-dominated fields. Irani (2004) studied students in beginning programming courses at Stanford University, interviewing them at the beginning and end of the semester to assess their feelings about the course. She was completing her research to verify that there was no inherent gender discrimination in the course, which was considered a "weeder" course. In her one-on-one interviews, a female student said that it was not talent or skill that made a better programmer; rather, it was the student's ability to deal with stress (Irani, 2004). Programming, computer problems, and network issues all exert a severe amount of stress on any person. Stress, by Merriam-Webster's definition, is a "constraining force or influence," or "a state...of bodily or mental tension resulting from factors that tend to alter an existent equilibrium." So, stress is an external force that directly affects one both mentally and physically, including effects on one's ability to perform mentally. While Irani did not exclusively study stress, she did find that it was a deciding factor in students' choices to continue their computer science studies at Stanford (Irani, 2004).

Not only do women experience more stress than men, they use different coping mechanisms (McDaniel, 2005). A study analyzing undergraduate technology students found that women are more likely than men to ask for advice and develop a plan of action when faced with a significant amount of stress in coursework (McDaniel, 2005). Furthermore, females were more likely than males to give up on a problem when they suspect failure (McDaniel, 2005). While it seems that women are more likely to deal with their stress than men, it is alarming that females are more likely to quit when they sense failure—perhaps stress has quite a large effect on the gender gap in technology.

Obviously, technology is not the only field where professionals experience stress—but do they experience a different kind of stress? Are women in male-dominated professions experiencing two major stressors—the anxiety of coursework as well as the threat of being a minority in the field? It seems likely that women in technology courses at the university level are experiencing extra pressure to do well in technology-oriented courses. There are many factors that influence one's confidence levels, including past accomplishments, the perceptions of others, verbal feedback, and the physical and emotional well-being of the individual. For women in technology, perhaps the most important of these sources is one's perceptions of one's peers: being in a male-dominated setting means that women will see how males perform and compare that with their own performance and speed at finishing a task. As a result, they will feel that they do not belong in IT. Furthermore, while all of these sources affect how one measures his/her ability to perform well on a task, the emotional well-being of an individual is particularly relevant in stressful situations such as meeting deadlines for programming or project assignments. Many students in IT may assess their performance abilities based on their efficiency or inefficiency in handling stress.

THE IMPORTANCE OF THE COLLEGE YEARS

Throughout secondary school, it has been found that girls and boys are equally likely to take advanced courses in science and mathematics; however, once they reach university-level courses, men take over the two fields (Zeldin & Pajares, 2000). This decrease in participation in science and mathematics courses has also been explained by confidence levels (Gürer & Camp, 2002; Lips, 2004). Furthermore, it is also interesting to note that, when compared with other majors, computer science shows a gender gap in self-perceived abilities on tests (Beyer, 1999). Females in introductory sociology and psychology courses (which are traditionally feminine fields) have higher confidence levels on tests when compared with introductory computer science courses where females perceive their test-taking abilities as much lower than their male counterparts (Beyer, 1999). Similarly, Lips (2004) found that high school males and females see themselves on equal footing in the sciences, with relatively no gender disparity. However, at the university level, there is a much larger gender gap when it comes to interest in the sciences. Worse yet, women's confidence levels significantly drop over time while men see theirs as potentially increasing. This data supports the conclusion that there is a self-esteem problem that influences the gender gap.

Due to the stereotypical view of technological careers, both high school and university-aged females feel that technology is not something that would keep their interest throughout a career (Clarke & Teague, 1996). The career women interviewed in Clarke and Teague's study have a much different take on the world of technology: they do not see it as a world of cubicles and social ineptness, as do younger women. Rather, they see it as a source of "variety, challenge, working with others, and helping people" (p. 244). These findings suggest that the lack of knowledge about the IT world has contributed to women's drop of interest in studying computer and information science. Perhaps a change of perception is in order so that younger women may view technology differently. The evidence suggests that, in addition to the potential negative influence of peer comparisons and stress on women's self-confidence, their self-assessments of their abilities in science and mathematical fields tend to drop as they move from high school to college. Women's perceptions of their own abilities decrease during these years, while the self-assessments of their male peers tend to increase. In addition, the lack of correct information about IT careers leads young women to conclude that those careers would not be of interest to them.

FUTURE TRENDS

Our first step is to gain a better understanding of women's low (and decreasing) self-confidence in their technology-related abilities during the college years. Studies on the confidence gap should begin with very young children and their gendered toys—in our society, girls tend to get domestic toys and boys tend to get things like video games or other machinery (i.e., something they can dismantle and put back together). Studies should continue as children enter school and visit the computer lab—is it male-dominated already? What role do the females take? These questions should be explored all the way through secondary education, at which time students should be given an accurate image of a technology professional. For the post-secondary level, perhaps giving young women a more realistic impression of what information technology professionals do would help eradicate some of the gender discrepancies.

In addition, we need to take positive steps to improve young women's technology self-efficacy. Zeldin and Pajares (2000) believe that self-efficacy beliefs of females in male-dominated fields are derived from positive feedback and encouragement from significant others. While past research has indicated that feedback from significant others is most influential among women, positive feedback from educators could potentially be just as significant. Such feedback should start at an early age; we must present young girls with the knowledge that they are equal to their male peers and possess the ability not to simply make it into the technology field, but to succeed. By teaching young girls (and young women) that a technology job doesn't have to be some guy sitting in a dark room programming all day long, we put a new face on technology. That face should know no boundaries of sex, race, or class.

CONCLUSION

Since some of the initial pioneers in the technology field were women, it seems natural that this would be an area where women can excel. Unfortunately, the number of women in computer science and information science programs is continuing to decline (Lips, 2004; NCES, 2003; Saye, 2004) and, thus, information technology fields are losing an important segment of their workforce. There are many factors that go into understanding the gender gap in the IT workforce. Everything from the nature and culture of the technical world to gender barriers to individual psychological factors influences one's choice of profession in the scientific/technical realm.

When women are in technological courses their lack of self-confidence seems to be keeping them from furthering their studies. Indeed, the confidence level of females decreases as they get older and progress further in their education (Lips, 2004; Zeldin & Pajares, 2000). Explanations for this decrease in confidence can include negative comparisons of themselves with their male peers and interactions between the stress experienced by women in technology courses and these peer comparisons. Furthermore, young women in secondary schools have a very distorted view of technology professions. They see technology as a world of machinery, lacking human interaction (Wilson, 2003). With this inaccurate outlook, many girls are turned away from technology and see it more as a means rather than an end (Huang et al., 1998). Without intervention it seems that females will continue to be turned away from the world of computing.

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KEY TERMS

Information Technology Workforce: The people holding jobs described as being technologically related; (i.e., those who identify themselves as technology professionals).

Self-Confidence: "Individuals' beliefs about their competencies in a given domain [which] affect(s) the choices they make, the effort they put forth, their inclinations to persist at certain tasks, and their resiliency in the face of failure" (Zeldin & Pajares, 2000).

Self-Efficacy: "People's beliefs in their capabilities to perform in ways that give them control over events that affect their lives" (Kazdin, 2000).

Self-Perceived Abilities: One's self-assessment of skill at a particular activity. These perceptions have an affect on performance capabilities, choices, and effort towards an activity (Zeldin & Pajares, 2000).

Stereotype: "Beliefs about particular social groups" (Kazdin, 2000). Stereotypes occur when society as a whole "repeatedly applies the same attributes to people belonging in the same group" (Kazdin, 2000).

Stereotype Threat: "The threat that others' judgments or their own actions will negatively stereotype them [minorities] in the domain" (Steele, 1997).

Stress: The "obstacles, challenges, and threats to [one's] environment" (Kazdin, 2000). One's reaction to stress is used to measure success (Kazdin, 2000).

ENDNOTE

1 Binary means that something can only be one or the other; there is no in-between, analogous to the binary numbering system where everything must be either a one or a zero. The same is true for gender in American culture where everything is defined as either masculine or feminine. What I mean by weeder is that the course is set up to be incredibly difficult so as to fail all but the 'real' or 'true' CS majors. It is a common term used among university students. (Preparing for the IT Workforce, p. 10).

Gender Equalization in Computer–Mediated Communication

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INTRODUCTION

While traditional face-to-face (FtF) forms of interaction have proven disadvantageous to females in mixed-sex settings, computer-mediated communication (CMC) holds the promise of helping to level the playing field between the sexes, at least in terms of equitable communication between genders. However, evidence from resent research shows that gender inequalities persist. The objective of this article is to shed light on why the promise of gender equalization in CMC is not evidenced.

BACKGROUND

The equalization phenomenon of CMC is attributed to the reduction in social cues associated with an online virtual environment (Dubrovsky, Kiesler, & Sethna, 1991; Kiesler, Siegel, & McGuire, 1984; Kiesler, Zubrow, Moses, & Geller, 1985; Siegel, Dubrovsky, Kiesler, & McGuire, 1986). In this comparatively lean mode of interaction, it is argued, status cues are filtered out, which leaves people feeling more anonymous and less individual. This "deindividuation" lowers self-awareness and self-regulation, resulting in less evaluation apprehension and overall reduced social inhibitions. According to Kiesler et al., the relative distance and anonymity afforded by CMC decreases the salience of status, resulting in the increased participation of lower status members. The emphasis shifts from message contributor to message content, thus serving to equalize the influence of high-status individuals.

Indeed, a repeated finding in the early research in this area is that both participation in group discussion as well as influence over group outcome is more equal under conditions of asynchronous CMC compared to traditional FtF interaction (Clapper, McLean, & Watson, 1991; George, Easton, Nunamaker, & Northcraft, 1990; Hiltz, Johnson, & Turoff, 1986; McLeod, 1992; Rice, 1984; Zigurs, Poole, & DeSanctis, 1988). Females, being of lower status than males (in most cultures), are thus expected to fair better in a CMC context as compared to a traditional FtF context. However, as pointed out by Postmes and Spears (2002), many studies of electronic media use have not found evidence to support the equalization hypothesis (Adrianson & Hjelmquist, 1991; Berdahl & Craig, 1996; Hollingshead, 1996; Matheson, 1991; Saunders, Robey, & Vaverek, 1994; Straus, 1996; Weisband, 1994; Weisband, Schneider, & Connolly, 1995).

REVIEW OF LITERATURE

The article begins by reviewing literature on status, particularly as it relates to gender differences in traditional FtF communication environments before moving into CMC environments. The focus of the review concerns mixed-sex, task-oriented work situations.

Sociological-Based Theories

Sociological-based theories pertaining to status include status-characteristics theory (SCT) and social-role theory. SCT is concerned with the effects on face-to-face interaction of differences in individuals' status. A central tenet of SCT is that status hierarchies influence interaction in groups (see Wagner & Berger, 1993, 1997, for summaries). Findings indicate that high-status members contribute more opinions and enjoy increased influence in groups. Regarding gender, males are accorded a higher status than females and are believed to have more expertise overall (e.g., Eagly & Carli, 1981; Kent & Moss, 1994; Wood & Karten, 1986). Thus, both sexes expect higher task performance from males, independent of whether gender is relevant to the group's task at hand (Berger, Rosenholtz, & Zelditch, 1980). In mixed-sex groups, females contribute less task-relevant content due to the expectation of superior male performance. As pointed out by Johnson et al. (1998), these findings are consistently supported (Anderson & Blanchard, 1982; Dovidio, Brown, Heltman, Ellyson, & Keating, 1988; Lockheed & Hall, 1976; Piliavin & Martin, 1978; Strodbeck & Mann, 1956; Woody & Karten, 1986).

The SCT research considers traditional FtF interaction. In an attempt to tease out the effect of differing degrees of FtF interaction on the effects of status, Mueller et al. (2002) found that the predictions from SCT are more likely to be supported when "women and men regularly interact face-to-face" (p. 178). Thus, they conclude that the amount of face-to-face interaction best predicts whether SCT's claims on gender inequalities will be supported.

Social-role theory (Eagly, 1987) asserts that males and females are socialized differently such that each sex learns dissimilar (i.e., gender-appropriate) behavioral patterns. Females are socialized to respect and defer to males and to exhibit relative docile behavior (Seibert & Grunfeld, 1992). Males, on the other hand, are socialized to be more assertive, competitive, and aggressive (Eagly & Steffen, 1984; Powell, 1988).

These socialization processes result in individuals exhibiting stereotypical traits and behavior associated with their gender, which is reflected within the interaction of participants in mixed-sex groups (Broverman et al., 1972; Eagly & Steffen, 1984; Strodbeck & Mann, 1956). This body of research generally finds that males participate more and are more influential in mixed-group settings than their female counterparts (e.g., Eagly & Carli, 1981; Williams, 1992). Males also emerge more frequently as group leaders (Eagly, 1987). These findings hold regardless of the sexual composition of the group (see below). Although social roles have become less rigid over the years, gender stereotypes continue to persist (Biernart & Wortman, 1991; Diekma & Eagly, 2000; Steil, 1997).

Structural Theory

The theory of proportional representation (Kanter 1977a, 1977b) provides a structural approach for accounting for within-group behavior due to status differences. It posits that the numerical representation of a status category (e.g., race, sex) influences intragroup interaction. A group member from the numerical minority experiences feelings of isolation and powerlessness. This leads to behavior by the numerical minority that tends toward passive and inhibited conduct. As a means of lessening the feelings of isolation and powerlessness and to fit in, the numerical minority may adopt the behavioral characteristics of the numerical majority. These behaviors are evident in "tilted" groups, where group members account for between 15% to 35% of the minority status, but are more prevalent in "skewed" groups, where they represent less than 15% of group membership. Polarization occurs as the numerical majority alienates the numerical minority by discounting contributions of the minority.

In terms of mixed-gender groups, proportional-representation theory suggests that the numerical representation of men and women directly influences behavior rather than the sex or socialized-gender roles of the individuals themselves. Research suggests that the results of proportional representation are quite direct. For example, Johnson and Schulman (1989) found that solo female members engaged in task activities significantly below the group average. However, there is evidence that men and women are differentially affected by underrepresentation. That is, when females are in the majority and there is a lone male group member, the solo male may dominate (e.g., Crocker & McGraw, 1984; Williams, 1992).

Linguistic Differences in Communication of Men and Women

Researchers within the area of sociolinguistics have uncovered numerous differences in the way males and females use language to communicate and interact. These differences occur to such an extent that sex-specific patterns of communication are evident in discourse (Coates, 1986; Preisler, 1987). Men's discourse is more competitive and involves preserving their independence, while women's is supportive, consensus seeking, and socially oriented (Coates; Preisler; Rhodes & Wood, 1990). Women express more agreement and seek the opinions of others to a greater extent than men (Eakins & Eakins, 1978).

In both mixed and homogeneous groups, men contribute more task communication (e.g., Bartol & Butterfield, 1976; Ellis & McCallister, 1980; Hare, 1976; Nemeth, Endicott, & Wachtler, 1976; Strodbeck & Mann, 1956; Sturm, 1989). Women, however, contribute more to statements relating to group maintenance (e.g., Bartol & Butterfield; Ellis & McCallister, 1980; Strodbeck & Mann; Sturm). While both task and group-maintenance communication is necessary for effective group functioning (Bales, 1950), leadership is consistently attributed to those who contribute task, rather than maintenance, input (e.g., Hare; Nemeth et al.; Strodbeck, James, & Hawkins, 1957).

Specific linguistic features are also associated with each sex. Females use more expressive and emotional language, and their language incorporates a variety of markers that males do not tend to use (Lakoff, 1975). These markers include hedges (e.g., "I'm not sure, but…"), (very) polite forms (e.g., "I'd really appreciate it if…"), tag questions (e.g., "You're leaving now, aren't you?"), direct quotes (men paraphrase more often), and apologies (e.g., "I'm sorry, but I feel that..."). Women also speak less frequently than men in mixed-sex settings.

Gender-Equalization Studies in Asynchronous CMC

While there is a body of research pertaining to equalization and status in CMC (see above), the number of studies specifically relating to gender equality in CMC is quite sparse. Studies purporting the status-equalizing effects of CMC do so based on non-gender-related status markers (e.g., occupation, Saunders et al., 1994; education, Weisband et al., 1995). By and large, CMC research has not studied gender equalization or controlled for gender effects. Below, I review CMC studies relating to gender equalization.

Selfe and Meyer (1991), in one of the earliest studies to report on gender in CMC, found that males and other high-status members dominated online interaction under normal as well as anonymous conditions. Herring has conducted a series of studies on gender in CMC. In a particularly telling study, Herring (1992, 1993) conducted a 5-month-long analysis of two academic Listservs. In her study of their discourse, she identified linguistic features associated with each gender. These features comprised significant sex-based differences, such that they formed a style recognizable as woman's language and men's language. The features of women's language included explicit justifications, questions, apologies, personal orientation, and support of others. In contrast, men's language included strong assertions, self-promotion, rhetorical questions, authoritative orientation, humor, and sarcasm. These findings are similar to the aforementioned linguistic differences noted in traditional FtF interaction.

Furthermore, in terms of participation, Herring (1993) found that a minority of men dominated the discourse for both the amount and content of contributions. She notes that "the most striking sex-based disparity is the extent to which men participate more than women" (p. 4). Although women constituted between 36% and 42% of the membership on the Listservs, their communication rate was significantly less than what would correspond to their numerical presence. Herring goes on to relay that when women attempted to participate on a more equal basis, they were actively censored by men who either ignored their contributions or attempted to delegitimize their postings. Herring observes that because women are conditioned to avoid conflict, they avoided participating. She concludes that

> *[r]ather than being democratic, academic CMC is power-based and hierarchical. This state of affairs cannot however be attributed to the influence of computer communication technology; rather, it continues pre-existing patterns of hierarchy and male dominance in academia more generally, and in society as a whole.* (p. 11)

Recently, Postmes and Spears (2002) conducted a series of laboratory studies on equalization in groups communicating via CMC by looking at dominance, the antithesis of equalization. All teams consisted of four undergraduate students and were balanced in terms of sex (i.e., two females, two males). They analyzed dominance in terms of the content of contribution, and also counted the number of words and postings of the participants. While their studies did not show evidence of male dominance in terms of word or statement counts, males were found to dominate team discussions in terms of linguistic style. Males used forceful, independent, confident, and assertive language in order to dominate. Furthermore, under conditions of supposed anonymity, gender differences were more salient. They attribute this to the inability to be truly anonymous when communicating. Due to patterned differences in the discourse of men and women, it is thus likely that gender can be determined even under anonymous conditions where gender is hidden.

Postmes and Spears (2002) conclude that the prior mixed findings regarding equalization can be attributed, at least in part, to employing an inappropriate measure based on a numerical count. Their focus on measuring content differs from previously cited studies that found equalization in CMC, which relied on measures of equalization based on the numeric count of words and postings. Postmes and Spears warn that researchers must consider the content of the contributions to determine a true measure of the equality of participation and influence.

FUTURE TRENDS

There is certainly room for more gender studies in CMC. While studies by linguists (Herring in particular) have informed our understanding of gender differences in CMC in terms of discourse, these field studies have largely been conducted using discussion boards. While other studies of status and equalization have been conducted using task-oriented teams, most have not looked at gender. And while there are some studies of gender on teams interacting via CMC, these do not consider status and equalization. Finally, there are no studies that focus on the gender composition of teams as an independent variable.

CONCLUSION

What can be concluded from the limited research is that CMC does not promote gender equalization. Many of the conditions leading to gender inequality in traditional FtF interaction find their way into the context of CMC. As described by sociological theories as well as structural theories, status effects relating to gender appear to carry over into CMC. However, significant gaps in gender research in CMC remain.

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KEY TERMS

Computer-Mediated Communication (CMC): Electronic communication using a computer.

Deindividuation: The loss of individual identity and a gaining of the social identity of a group.

Equalization Phenomenon: The salience of status is decreased by interacting in a CMC environment; it is a hypothetical result.

Expectation-States Theory: Argues that power and prestige differences within a group arise from differing performance expectations that members hold for themselves and others.

Heterogeneous Group: Mixed-sex group (i.e., male and female group members).

Homogeneous Group: Same-sex group (i.e., all female or all male).

Lean Mode of Interaction: Due to the reduction in social cues, CMC is considered lean compared to face-to-face interaction.

Social-Role Theory: Asserts that males and females are socialized differently such that each sex learns dissimilar (i.e., gender-appropriate) behavioral patterns.

Status-Characteristics Theory (SCT): Is concerned with the effects on face-to-face interaction of differences in individuals' status; a central tenet of SCT is that status hierarchies influence interaction in groups.

Theory of Proportional Representation: Provides a structural approach for accounting for within-group behavior due to status differences; it posits that the numerical representation of a status category (e.g., race, sex) influences intragroup interaction.

Gender ICT and Millennium Development Goals

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INTRODUCTION

Gender equality and information and communication technology are important in the achievement of the Millennium Development Goals (MDGs) in policy, planning, and practice. The 2000 Millennium Declaration of the United Nations (UN) formed an international agreement among member states to work toward the reduction of poverty and its effects by 2015 through eight Millennium Development Goals:

1. Eradicate extreme poverty and hunger
2. Achieve universal primary education
3. Promote gender equality and the empowerment of women
4. Reduce child and maternal mortality
5. Improve maternal health care
6. Combat HIV and AIDS, malaria, and other major diseases
7. Ensure environmental sustainability
8. Develop global partnership for development

Progress toward gender equality and the empowerment of women is one goal that is important to achieving the others. Poverty, hunger, illiteracy, environmental threats, HIV and AIDS, and other health threats disproportionately affect the lives of women and their dependent children. Gender-sensitive ICT applications to education, health care, and local economies have helped communities progress toward the MDGs. ICT applications facilitate rural health-care workers' access to medical expertise through phones and the Internet. Teachers expand learning resources through the Internet and satellite services, providing a greater knowledge base for learners. Small entrepreneurs with ICT access and training move their local business into world markets.

ICT diffusion into world communication systems has been pervasive. Even some of the poorest economies in Africa show the fastest cell-phone growth, though Internet access and landline numbers are still low (International Telecommunications Union [ITU], 2003b). ICT access or a lack of it impacts participation, voice, and decision making in local, regional, and international communities.

ICTs impact the systems that move or inhibit MDG progress. UN secretary general Kofi Annan explained the role of the MDGs in global affairs:

> *Millennium Development Goals are too important to fail. For the international political system, they are the fulcrum on which development policy is based. For the billion-plus people living in extreme poverty, they represent the means to a productive life. For everyone on Earth, they are a linchpin to the quest for a more secure and peaceful world.* (UN, 2005, p. 28)

Annan also stressed the critical need for partnerships to facilitate technology training to enable information exchange and analysis (UN, 2005). ICT facilitates sharing lessons of success and failure, and progress evaluation of work in all the MDG target areas.

Targets and indicators measuring progress were selected for all the MDGs. Gender equality and women's empowerment are critical to the achievement of each other goal. Inadequate access to the basic human needs of clean water, food, education, health services, and environmental sustainability and the support of global partnership impacts great numbers of women. Therefore, the targets and indicators for Goal 3 address females in education, employment, and political participation. Progress toward the Goal 3 target to eliminate gender disparity in primary and secondary education, preferably by 2005, and in all levels of education no later than 2015, will be measured by the following indicators.

- Ratio of girls to boys in primary, secondary, and tertiary education
- Ratio of literate females to males who are 15- to 24-year-olds

- Share of women in wage employment in the nonagricultural sector
- Proportion of seats held by women in national parliaments (World Bank, 2003)

Education is positively related to improved maternal and infant health, economic empowerment, and political participation (United Nations Development Program [UNDP], 2004; World Bank, 2003). Education systems in developing countries are beginning to offer or seek ways to provide ICT training as a basic skill and knowledge base.

Proactive policy for gender equality in ICT access has not always accompanied the unprecedented ICT growth trend. Many civil-society representatives to the World Summit on the Information Society (WSIS) argue for ICT access to be considered a basic human right (Girard & Ó Soichrú, 2004; UN, 1948).

ICT capability is considered a basic skill for education curriculum at tertiary, secondary, and even primary levels in developed regions. In developing regions, ICT access and capability are more limited but are still tightly woven into economic communication systems. ICTs minimize time and geography barriers.

Two thirds of the world's poor and illiterate are women (World Bank, 2003). Infant and maternal health are in chronic crisis for poor women. Where poverty is highest, HIV and AIDS are the largest and fastest growing health threat. Ninety-five percent of people living with HIV and AIDS are in developing countries, partly because of poor dissemination of information and medical treatment. Women are more vulnerable to infection than men. Culturally reinforced sexual practices have led to higher rates of HIV infection for women. Gender equality and the empowerment of women, starting with education, can help fight the spread of HIV, AIDS, and other major diseases. ICT can enhance health education through schools (World Bank).

Some ICT developers, practitioners, and distributors have identified ways to incorporate gender inclusiveness into their policies and practice for problem-solving ICT applications toward each MDG target area. Yet ICT research, development, education, training, applications, and businesses remain male-dominated fields, with only the lesser skilled and salaried ICT labor force approaching gender equality. Successful integration of gender equality and ICT development policy has contributed to MDG progress through several projects in the developing regions. Notable examples are the South-African-based SchoolNet Africa and Bangladesh-based Grameen Bank Village Pay Phone. Both projects benefit from international public-private partnerships. These and similar models suggest the value and importance of linking gender equality and empowerment with global partnership for development, particularly in ICT.

This article reports on developing efforts to coordinate the achievement of the MDGs with policy, plans, and practice for gender equality beyond the universal educational target, and with the expansion of ICT access and participation for women and men. The article examines the background and trends of MDG 3, to promote gender equality and the empowerment of women, with particular consideration of MDG 8, to develop global partnership for development, in ICT access and participation.

BACKGROUND

The United Nations convened the Millennium Summit in September 2000, which produced the Millennium Declaration and eight Millennium Development Goals to eliminate poverty and its effects. Targets were defined for each goal to be achieved by 2015. The evaluation of national progress on each goal has been ongoing since 2000. The UNDP and the Millennium Campaign are affirming national accountability through monitoring progress on the measurable indicators for each target. The UN struggle to uphold human rights to equality and freedom from want began with its founding mission and the United Nations *Universal Declaration of Human Rights* (UDHR; UN, 1948).

All UN member nations committed to the MDGs and targets developed through the summit. Each nation regularly reports its progress and is accountable for national achievement toward the goals.

The goal of gender equality has been advanced internationally through treaties and agreements. Arguments for gender equality in ICT policy and development were supported by the precedent agreements of the *Universal Declaration of Human Rights* (UN, 1948), the Convention on the Elimination of all Forms of Discrimination against Women (CEDAW; United Nations Commission on the Status of Women [UNCSW], 1979), the Beijing Platform for Action (UN, 1995), and then the Millennium Development Goals declared in 2000.

Development research links gender equality to the MDGs for poverty reduction. Gender equality is linked to the sustainability of development strategies. Policy to promote gender equality through institutional reform can strengthen the sustainability of economic development programs with more equal participation and resource distribution (World Bank, 2003; King & Mason, 2001). A main source of development funds, the World Bank is positioned to provide material support for gender-equality policy. In 2005, the World Summit on the Information Society reached closure with open issues on financial mechanisms, such as the Digital Solidarity Fund to expand digital rights for all.

World Bank (2003) research focused on ICT's role in addressing poverty:

ICTs have enormous potential to reach dispersed and rural populations and provide them with education and training, job opportunities, access to markets, availability of information important to their economic activities and greater participation in the political process. (p. 7)

Research was centered on gender-based differences in how ICT was used to enable poor women and men to participate in the world economy. Gender-focused analysis has resulted in a critique of the MDG targets and assessment indications as being too focused on economic issues and not enough on social- and political-justice issues. The goal targets do not address war and domestic violence against women, a significant health threat and factor in social, political, and economic gender exclusion (Ain Tahmina, 2005).

The International Telecommunications Union, one of the earliest international organizations, was formed in 1867 in the early days of telegraph and telephone. Now an agency of the UN, the ITU facilitates the international coordination of telecommunications resources like spectrum and technical standards, and provides a forum for policy making and ICT development. The UN and the ITU convened the World Summit on the Information Society to develop a policy framework for the information society, including Internet governance. The documents *WSIS Declaration of Principles* and *WSIS Plan of Action* clearly link the purpose of ICT policy to the furtherance of the MDGs (UN, 2003a, 2003b). The UN ICT Task Force, the ITU Task Force on Gender Issues, the UNDP, and the Global Knowledge Partnership (GKP), which coordinated the civil-society segment of WSIS, have all addressed the MDGs in their plans, policies, and practice.

The ITU *World Telecommunications Report 2003* examined linkages between ICT and the MDGs, specifically articulated in Target 18 of Goal 8: "in cooperation with the private sector make available the benefits of new technologies, specifically information and communications" (ITU, 2003a, p. 71). Cooperative efforts targeting the goal help advance gender-equal ICT access and participation, and extend communication, information dissemination, and knowledge building to further the process of creating social change.

Gender equality in ICT development helping to advance progress toward MDG achievement was the idea given at WSIS by gender advocates. The WSIS Gender Caucus (2003) presented six recommendations for action to the WSIS plenary voting session in the spirit of "creating richness in the information society: inclusion, diversity and gender equality." The following main issues were identified and promoted by the WSIS Gender Caucus. Gender equality must be a fundamental principle for action. There must be equitable participation in decisions shaping the information society. New and old ICTs must be accessed in a multimodal approach. ICTs must be designed to serve people. ICT empowerment for women and girls is necessary for full participation. Research analysis and evaluation must guide action. These recommendations helped inform the development of the WSIS principles and platform for action (WSIS Gender Caucus).

The Global Knowledge Partnership (2002) was a major part of WSIS and recommended the following:

Include everyone in the digital revolution ... expand networks to reach underserved populations ... gender mainstreaming should be *a component of every ICT project to ensure sustainability. A gender perspective must be built into plans, policy and practice, from preliminary project design through implementation and evaluation.* (p. 10)

GKP recommendations included eight case studies of women involved in meaningful ICT projects that improved their economic and social well-being in developing communities around the globe. GKP recommendations to the Digital Opportunity Task Force suggested nine action points that included "[enhancing] human capacity development, knowledge creation and sharing" (p. 41). Policy goals to advance this action were the increase of Internet use in education, digital literacy with an emphasis on gender balance and youth, distance learning promotion in underserved areas, and the creation of a network of centres of excellence for research in ICT for development (GKP, 2003).

Chen, Vanek, Lund, Heinz, Jhabvala, and Bonner (2005) reported extensive research on women, work, and poverty, and defined six strategies for intervention into the identified trend of growing and gendered gaps in economic and overall well-being between and within regions:

Generally, women in the informal economy have not had much chance to learn different types of skills. This contributes to the difficulty their organizations have sustaining themselves and influencing employers and policy makers. Building capacity and skills at the grass-roots level through partnerships with other organizations and various supportive agencies can help remedy this. It is also increasingly important for organizations, especially larger ones and networks, to learn how to use communication techniques and modern information technology to link with each other. (p. 85)

The MDG international policy has been challenged as deflecting government attention and resources from CEDAW and the Beijing Platform for Action (BPFA) strategic objectives (Ain Tahmina, 2005).

FUTURE TRENDS

Government efforts toward gender equality and empowerment through ICT receive support through partnerships for development, which bring ICT applications in education, health care, and small business.

SchoolNet Africa is an example of a successful trend in coupling gender equality and empowerment through education with ICT development policy. SchoolNet Africa is an education and ICT model operative in 31 African countries. SchoolNet represents a productive public-private global partnership for development as recommended in the MDGs. SchoolNet Africa partnered with Microsoft and direct-to-home (DTH) satellite service provider Multichoice, based in Mauritius. International business, government, and non-governmental organization (NGO) support facilitate their network of 31 national SchoolNets. The enhanced information and knowledge exchange is building ICT skills in a new generation to participate as information-society citizens. Gender equality has been a key principle of SchoolNet Africa. The Web site http://www.schoolnetafrica.net updates its gender watch with research and information on gender networks, advances in ICTs, and the education of women and girls (World Bank, 2003).

Grameen Bank Village Pay Phone represents a successful trend of coupling gender equality and empowerment through business with ICT development. The ICT business entrepreneurs of Village Pay Phone are primarily women, who receive microcredit to purchase cell phones and provide pay-phone service in villages. The project began in Bangladesh, and its success has inspired replication projects in 30 developing countries. (Dumas, 1999)

The women entrepreneurs represent 4% of cellphone subscribers but 16% of the airtime. Grameen Bank founder Muhammad Yunus (2005) described the value of their work in expanding ICT access and the family economy:

Grameen Bank has provided loans to 129,232 borrowers to buy mobile phones and offer telecommunication services in nearly half of the villages of Bangladesh where this service never *existed before … Telephone-ladies play an important role in the telecommunication sector of the country, and also in generating revenue for Grameen Phone, the largest telephone company in the country. (Article 26)*

Other countries have gender-inclusive ICT development. Senegal, for example, has well over 7,000 small-business phone shops or telecenters, mostly operated by women. As local demand requires, some telecenters include computers, Internet access, duplication, printers, scanners, and fax machines (Dumas, 2002).

The UNDP (2004) report, 5 years after the commitments, found that much more work must be done in order to reach the targets and goals by 2015. The MDG campaign has brought visibility to world poverty, hunger, and health crises, as well as efforts to eliminate them. MDGs were on the agenda of the July 2005 meeting of the group of eight (G8) wealthy nations: the United States, Canada, United Kingdom, France, Germany, Italy, Japan, and Russia. Prior to the meeting, Jimmy Carter, former president of the United States, and others including the millions who participated in the LIVE 8 concerts, called on the G8 to make a greater contribution toward efforts to achieve the MDGs. During the meeting, the G8 responded to the call for expanded official development aid (ODA) to the poorest nations facing the greatest challenge to meet the MDGs. The innovative LIVE 8 concerts attracted the largest media audience in history and helped focus world and G8 attention on the MDGs.

CONCLUSION

Women are just over half of the world's population, but over two thirds of the world's poor and undereducated. Even in developed countries, women earn significantly less than men without exception (UNDP, 2004). The MDGs address the need for distributive justice to end poverty, hunger, and illiteracy in our world and bring greater peace and freedom to our collective lives. ICTs make global conversation and knowledge sharing possible, but unequal resource distribution has inhibited these communications. ICT has helped improve resource and service distribution for health care, education, economic empowerment, conflict resolution, political participation, and cultural enjoyment. Expanded access for and participation by women and youth is needed. The world nations are still far from achieving the eight MDGs (United Nations, 2005). The gender justice goals of UDHR (UN, 1948), CEDAW (UNCSW, 1979), Beijing (UN, 1995), the MDGs (2000), and the civil-society voices of ITU (2005) can be realized with the political will to do it. Nations have made the good-faith promise to achieve the MDG targets by 2015. Their mutual commitments within the UN forum with civil society's vigilance help reinforce accountability and resolve, and keep the goals and problems they address always in public view.

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KEY TERMS

Human Development Report (HDR): Annual report prepared and distributed by the UNDP on the development progress of all UN member nations. Since 2002, the HDR has included the Gender Development Index (GDI) for each nation state with available gender-disaggregated data

LIVE 8: A series of international live benefit concerts in July, 2005. They raised consciousness about the MDGs. It was held in the G8 countries and South Africa, and was seen on television worldwide by satellite (Wikipedia, 2006).

UNCSW: United Nations Commission on the Status of Women.

UNDAW: United Nations Division for the Advancement of Women.

UNDP: United Nations Development Program.

UNIFEM: United Nations Fund for Women.

WSIS: The World Summit on the Information Society is a two-phase international summit from 2003 to 2005 organized by the United Nations and the International Telecommunications Union to address the need for international policy and agreement on ICT governance, rights, and responsibilities.

WSIS Declaration of Principles (2003): The following is the vision of WSIS:

Our challenge is to harness the potential of information and communication technology to promote the development goals of the Millennium Declaration, namely the eradication of extreme poverty and hunger; achievement of universal primary education; promotion of gender equality and empowerment of women; reduction of child mortality; improvement of maternal health; to combat HIV/AIDS, malaria and other diseases; ensuring environmental sustainability; and development of global partnerships for development for the attainment of a more peaceful, just and prosperous world. (UN, 2003a, p. 1)

Gender Identity and Systems Development

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INTRODUCTION

This article draws on interviews and case study research on gender-IT relations to examine the relationship between gender identity and IT development activities. It explores the intertwining of gender and technological identity for women in office work contexts, a location where a boundary between the design and use of IT systems has long been recognised. It is important to explore identity construction within this framework of design and use as separate activities since women's identity is constrained on both sides of this perceived boundary. The article first explores issues for women as IT professionals, then as users of IT-based work systems and lastly, it discusses the feasibility of constructing gender identities that encompass and recognise the technical work that both developers and users do.

BACKGROUND

There has long been a feminist concern with the masculine construction of computer-based systems in European and North American gender and IT research. Statistical evidence continues to indicate male dominance in information systems development (Ahuja, 2002). The association between masculinity and technology remains strong and "men's affinity with technology is integral to the constitution of subjective identity for both sexes." (Wajcman, 2004, p.111) I have argued that gendered technology relations are implicit in this perceived boundary between the activities of design and use (Stepulevage, 2003). As Webster notes, "The very processes and methods used in the development of computer systems are carried out in a world apart from that of the workers who are the users." (1996, p. 148) Women's identity in relation to IT systems for office-based work is assumed to be that of "user" rather than designer or developer. Narratives by women about their experiences with computers and IT, however, demonstrate that there is a strong association between women and the development of computer technologies (Abbate, 2003).

Research on the development of IT office systems presents a complicated picture of how the identities of women IT professionals and office workers are viewed and how they situate themselves in relation to technical practices. It demonstrates that identity as a technologist is difficult to maintain for women IT professionals and difficult to claim for women clerical workers, as the following quotes demonstrate. A woman IT professional comments: "At its worst it can feel like people think women are only there to look pretty…or to make the systems look pretty." (Woodfield, 2002, p. 135), and a clerical worker interviewed during the implementation of a IT application notes, "I am not supposed to be interested in computers." (Stepulevage & Mukasa, 2005, p. 117). This article is concerned with questioning the constraints of a gendered boundary that situates men as the technical developers of IT systems and women as the users of these systems.

THEORETICAL APPROACHES

The gender and IT literature dealing with women's position as IT professionals and users can be said to conceptualise identity as either socially shaped or socially constructed. Both of these approaches firmly place the relations of technology as significant to identity construction.

A social shaping perspective focuses on women's identity as shaped through their life experiences, and skills and knowledge they have developed in everyday life. In a collection of papers concerned with the gendering of systems design, Bodker and Greenbaum (1993) discuss how different life experiences, especially those in employment, can influence ways of thinking about work activities such as IT systems development. They describe the typical professional IT developer as male, and they locate a masculine perspective on the "things" side of a "things vs. people" split, in which development activities are premised on a logical, reductionist approach that ignores the social relations of office life. Bodker and Greenbaum argue for a more inclusive approach to development, suggesting methods that enable cooperative design with office workers as active participants. This perspective challenges the separation between design and use in that IT professionals' identities are enlarged to encompass the social as well as the technical constituents of design activities, and office workers' identities are transformed from end-users to valuable contributors to the development process.

A social constructionist perspective analyses the construction of gender identity as a moving, relational process achieved in daily social interactions (Wajcman, 2004, p. 54). I draw on this conception of identity as it allows for changing interpretations of design and use activities as they intertwine with gender relations and constitute identity as a developer or user. Narratives and case studies of women systems developers offer examples of the significance of gender identity in the social interactions of development work. In Grundy's narrative of her experience of working in information systems in a local health authority, she describes development activities such as working with users to create new report formats, as being conceptualised by the dominant male group as the "messy" side of computer development. She notes that male developers, constituting their identity as technical, have little interest in this work and avoid it or do it badly. Grundy draws a link between this messy work and women's identity as bound up with housework (1994). Harvey notes that within the IT cultures she studied "woman is only allowed an identity through her role interaction with a man." (1997, p. 169) She examines her experiences of IT cultures in a number of work contexts and identifies four projected views of women, woman as victim, as wife, as prostitute, and as mother/carer of men, each identity mutually constructed as women carry out IT development in a male dominant culture.

WOMEN IT PROFESSIONALS AND IDENTITY

Gender and IT research has exposed some of the constraints that influence identity-construction for women working as IT professionals. Their identity is often categorised in extremes, such as being the "odd girl out" (Trauth, 2002) or aligning themselves with males as one of the boys (von Hellens, Nielsen, & Trauth, 2001). Women's outsider status is demonstrated in a "coke and pizza culture" where work takes precedence over domestic and leisure activities in order to complete IT projects (von Hellens et al., 2001). This literature engages with the difficulties of being a woman in a male-identified and/or male-dominated culture of IT development and notes that many women in IT shift from more technically-identified areas to people-identified ones. Woodfield notes that there has been a shift in the profile of the IT industry in the UK from workers with specialist technical skills to those who also are deemed to have social and communication skills (2002, p. 120). Her analysis of the dominant discourses in relation to social skills and IT development work provides evidence of the association between gender identity and development activities for these "hybrid" workers. One of the discourses questioned the effectiveness of the women's work. While women were credited with being able to improve relations, "these abilities were rarely related specifically or directly to the core, creative or constructive aspects of IT design and development" (p. 126). Another discourse indicates that social skills were valued, but they were more valued when associated "with the working personae of technical men" (p. 129). I believe that though this hybrid identity is an attempt to foster effective social relations within development work, it can also help constitute gender identity in ways that continue to devalue the social and promote the technical in constructing identity as a systems developer.

A persistent myth about women and IT is that women are not involved in IT development (Mortberg, 2000). Mortberg asks, as one of a number of women who have developed IT-based systems, "are we women?" While she does not develop an analysis of her question regarding gender identity, she is expressing a concern about destabilisation of gender identity that is also evident in other work on women IT professionals. Cockburn raised this issue in her early research on technology, "Technology enters into our sexual identity … The gendering of men and women into 'masculine' and 'feminine' is a cultural process of immense power" (1986, p. 12). I have explored the constraints of this gender binary for women in IT and argued that the performance of heterosexuality can serve as a counterbalance for women concerned with maintaining a female identity while doing a male-identified job (Stepulevage, 1997a). In order to counterbalance their performance of male-associated competences, women may perform systems development in ways associated with stereotypical roles for heterosexual women, (e.g., Grundy's experience of IT development as doing the "messy" work). I demonstrate how the IT press reflects this intertwining of sexuality and gender in a series entitled "on the job with [IT professionals]" where sexual and gender identity are conflated in descriptions of women's and men's daily activities (Stepulevage, 1997b). The narratives offer stereotypical heterosexual representations where women do a day's work at home before leaving for their IT job and when they return from it, while men stop for drinks at the pub before arriving home for a cooked meal. These constructed days in the life of IT professionals can be read as confirming that women in computing remain "real women" as demonstrated by their lives outside the office.

OFFICE WORKERS AND IT IDENTITY

In the gender and IT literature on office work, initially the focus was on office workers as users of IT. Research explored issues of job redesign and the deskilling and reskilling of women as end-users of IT-based office systems (Webster, 1996). There is also work that explored the design of software for clerical work (Clement, 1991; Hofmann, 1999). These studies challenge common assumptions made about office work, such as its routine and repetitive nature. Other research discusses the ways office workers tailored their software and associated work activities, a practice referred to as "designing without designers" (Clement, 1991) or participated in the analysis and redesign of their work processes to incorporate IT (Blomberg, Suchman, & Trigg, 1997). Stepulevage and Mukasa (2005) provide an example of these design activities. They describe the implementation of a large-scale software package that required modification in order to provide utility for its user group of clerical staff. The clerical workers' narratives of their experiences reflect a boundary between design and use in the implementation process, indicating that they were persistently excluded from formally recognised development activities. One worker, frustrated at this exclusion, developed a new application to process data from the newly implemented software. These studies show that while office workers may remain situated on the user side of the boundary in systems development projects, they also sometimes assume identities as developers.

CHALLENGING THE DESIGN/USE BOUNDARY

Some case studies and narratives focus directly on the question of women users' contributions to design. They can be said to explore a reconstruction of identity for users involved in systems development and a challenge to the design/use boundary. Clement (1994) summarises case studies in which women telephone operators and secretaries in a university became members of design teams. Ramsay, Panteli, and Beirne (1997) analyse the positioning of women clerical workers who are assumed to be users of an already designed software application. The clerical workers start writing programs in order to be able to supply the reports required by management, and eventually they come to be identified as technical developers as well as end-users of the system. In my experiences as an IT developer, I can identify the independent design and development activities of women accounting clerks in a context where the corporate IT department was expected to design and deliver IT applications to all departments (Stepulevage, 2003). In all these cases, the workers gained the confidence and support of their managers in order to develop the IT for their work systems. These studies demonstrate that identity as a user is concerned with the need to make IT applications useful and usable, and the opportunities to do so are grounded in the relations of power in office work. Workers may have the motivation and the knowledge to reshape the technology, but they also need the authority.

FUTURE TRENDS

In addition to the gender and IT research reviewed here, there is a body of work in the social studies of technology that deals with the transformative identity of user. It considers use as another site for the construction of the technology, where users contribute to its ongoing development. As McLaughlin, Rosen, Skinner, and Webster (1999) demonstrate in a number of case studies, the implementation of application packages can mean imposition of a technological mismatch with existing work practices for the workers involved. Workers then attempt to fit the application and their work practices together. Researchers have a variety of terms to refer to this activity, embedding the technology, tailoring it, integrating it into existing work practices. Work in cultural studies on the consumption of technical artefacts supports this interpretation from another angle, that of the consumer's ongoing relations with a technical artefact. This perspective recognises consumers as constructing meanings for the artefacts in their daily lives, and the artefacts contributing to the constitution of their identities. In these approaches, the agency of the user/consumer is recognised in relation to the ongoing development of a technology, and an identity as user might be reconstituted as user-developer or co-designer.

These perspectives which consider the development of IT applications as an ongoing activity rather than within a closed systems life cycle are important as they challenge the constraints of a developer/user boundary, and they open the possibility for women office workers to construct their identities in ways that challenge static gendered identities as users. Instead of being a user, office workers' identities can be constituted in relation to the development work that they do as they embed technical artefacts within their everyday work practices. There is potential for shifts in identity by IT developers as well. They are becoming purchasers of software packages rather than designers of technical artefacts. In the implementation of these packages, they must have interactions with various user groups who, due to a general rise in computer literacy, no longer need to be trained in the syntax of computer interfaces (Turner, 2004, p. 118). These changes in technology and context have the potential to weaken the divide between developers and users in that technical knowledge of the software cannot necessarily be claimed by the IT developer who has responsibility for its implementation.

CONCLUSION

Systems development in general is no longer about introducing bespoke systems. Today most computer application systems are bought "off the shelf" and there is growing recognition that IT professionals and office workers who use IT systems must interact to develop an effective work system. However, research from the general IT literature fails to provide many positive examples of challenging the boundary between designers and users. In a case study of implementation of an application system in an insurance company, Turner describes how a model office is used as a site to tailor packages. The "domain experts" who tailor the application, however, are not the local workers; rather, these domain experts are often supplied by the application system vendor (Turner, 2004, p. 120). Office staff are given training in the model office with their identities constructed as users who have no involvement with development of the application.

I have indicated that there is a trend within computing toward more malleable systems, which can shift design opportunities toward the user. It is evident from recent case study research concerned with gender relations, however, that the gendered divisions of work in IT persist. My own and other feminist research shows that implementation practices continue to exclude female IT users from identifying as developers and continue to devalue the contributions of women who identify as IT developers. Detailed empirical studies are valuable in that they can support a case for challenging the separation between activities currently categorised as design or development and those categorised as use, and for unravelling the inequalities in the construction of gender identity in relation to IT so that technical skills and knowledge can be claimed as an aspect of identity for all.

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KEY TERMS

Cooperative Design: An approach in which computer applications are designed in negotiation with user groups in the workplace; both users and designers gain knowledge and skills through the interaction.

Development Activities: A term that identifies people's engagement with the construction of computer-based systems. It conventionally refers to technical activities such as programming, but it is a socially constructed term that has various meanings depending on the people identified as doing the developing, the situation in which a system is developed, and the power relations between IT professionals and user groups.

Office Work: Secretarial, clerical and administrative work; in the US and UK the majority of these positions are associated with and held by women.

Systems Life Cycle: A model of systems development that structures activities as an ordered, sequential series of defined stages from initiation to completion.

Tailoring: A concept used to identify the work of modifying software to meet local needs; it may be done by IT professionals or by user groups after software is implemented.

Use: A term that identifies people's engagement with computers. It conventionally refers to engaging with an already completed artefact such as an application package, but it is a socially constructed term that has various meanings depending on the people doing the using, the situation in which an artefact is used, and the power relations between users and interpreters of use.

Work Systems: Human activity systems enabling the daily activities of a work group where IT is embedded to support specific work tasks.

Gender Identity, the Culture of Organizations, and Women's IT Careers

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INTRODUCTION

The decreasing number of women in information technology (IT) programs and careers has received increasing attention over the last decade (Arnold & Niederman, 2001; Camp, 1997; Cukier, Shortt, & Devine, 2002; Klawe & Leveson, 1995; Niederman & Mandviwalla, 2004). The proliferation of technology innovations over the last 20 years has made the computer less of a mystery to the general public and placed it in a more prominent place in both the office and home. The integration of networks and the placement of the personal computer as a new artifact in society has signaled both cultural as well as technological changes for the future (Woodfield, 2000). However, bigger transformations are yet to emerge. The future efforts of technology will focus on areas such as artificial intelligence, robotics, and bio-technology and implications are significant. Yet, despite these major changes, organizational cultures across businesses appear to have retained their masculine bias or feel. If the current trend of under representation of women in the IT field continues (Camp, 1997; Klawe & Leveson, 1995; MacInnis & Khanna, 2005), these future developments will be without the influence of women, and IT will become entrenched in the public psyche as a masculine pursuit (Woodfield, 2000).

The purpose of this article is to present an overview of organizational culture and its influence on gendering identities. Further, an exploration of the evolution of organizational culture within the IT discipline will be offered to assist with our understanding of why fewer women are pursuing IT careers.

ORGANIZATIONAL CULTURE

The concept of *organizational culture* can be traced back to the early 1940s when Kurt Lewin argued that "a factory was much more than a structure of production lines; it was the creation of a group with certain patterns of leadership, and any progressive factory management had to consider "total culture," which meant all aspects of group life" (Marrow, 1969, p.180). Nonetheless, the concept did not become popular until the 1980s when US businesses, facing sharp competition, looked for explanations of the success of their Japanese competitors (Martin, 2002). The appeal of organizational culture is four-fold: (1) it is linked with organizational success—initially with the competitiveness of Japanese companies (Pascale & Athos, 1981), but later with a range of European and North American companies (Helms Mills, 2003); (2) it takes a multi-layered approach—focusing on the interrelationship between various elements of an organization (e.g., beliefs, symbols, structure, ceremonies) rather than any single element; (3) it goes beyond the purely rational elements (e.g., rules, regulations, systems) to examine the subjective processes and outcomes (e.g., feelings, atmosphere, or climate) of an organization; and (4) it nonetheless appears relatively easy to apply (Davies, 1984).

The ensuing debates around organizational culture over the past three decades have generated several major schools of thought, ranging from those who view organizational culture as a real entity—something that can be studied as if it were a concrete entity—to those who view it as a social construct or heuristic for making sense of organizational behaviour and outcomes (Martin, 2002). As we shall see below, feminists tend to take the latter approach. The debate has also generated over two hundred definitions of organizational culture (Ott, 1989) but they share several things in common, including: (1) a focus on the interrelationship between different levels of an organization, with a tendency to view organizations as mini-societies (Brown, 1998); and (2) a distinction between the manifestations or artifacts (e.g., dress, symbols, language) and the underlying drivers (e.g., values, beliefs) of an organizational culture (Schein, 1992). For the purposes of simplicity, we shall use the term organizational culture to refer to a heuristic or framework that examines *the configuration of beliefs, values, and assumptions that influence organizational practices and associated feelings and emotions*.

GENDER IDENTITY AND ORGANIZATIONAL CULTURE

Feminist organizational scholars have greeted the development of an organizational culture focus with a mixture of interest and bewilderment. Interest stems from the promise of organizational culture to shift attention away from purely technical processes and outcomes to concerns around the socio-psychological impact of organization on the people involved. For feminists, following Oakley's (1972) distinction between "sex" as the physiological features of people and "gender" as the cultural understandings that come to be associated with those features, organizational culture can help us to explore the way that organizations contribute to gendered identities (Gherardi, 1995; Mills, 1998; Morgan, 1988). Bewilderment stems from the fact that gender has largely been ignored by the debate (Wilson, 2001) much as it has been from mainstream organizational analysis (Hearn & Parkin, 1983). In recent years a substantial body of feminist research has examined the impact of organizational culture on gendered outcomes, including discriminatory practices and the social construction of men and women (Helms Mills, 1988, 2002), and developed research strategies and strategies of culture change to deal with discrimination at work (Aaltio & Mills, 2002; Ely, Scully, & Foldy, 2003; Maddock, 1999; Mills, 1998, 2002). Much of this research suggests that organizational culture not only results in discrimination *against* women but also contributes to discriminatory notions of women (and men). For example, where commercial airlines only hire male pilots because of supposed qualities of courage, skill and military experience they are simultaneously creating a masculine identity of piloting and excluding women from that role (Mills & Helms Mills, 2004). Similarly, where commercial airlines restrict flight attending to female applicants based on the notion that the job requires care and attentiveness this serves to reinforce the association between those characteristics and women while excluding men from the position (Cockburn, 1985, 1991). Gender identity, thus, refers to the regular association of certain characteristics with men, and the regular association of certain other (often opposite) characteristics with women. These associations revolve around notions of sexuality and are often assumed to characterize particular types of men (e.g., strong; silent; effeminate) and women (e.g., the girl next door; femme fatale; butch).

INFORMATION TECHNOLOGY AND GENDERED IDENTITIES

On the surface technology may appear to be gender neutral. Certainly types of machines, such as the printing press, the airplane, the lathe, or the computer do not, in their construction, seem to be associated with male or female characteristics. Yet, as various feminist studies have revealed, certain technologies are very much associated with men, including printing (Cockburn, 1991), piloting (Mills, 1998), engineering (Wilson, 2002), and computer programming (Kramarae, 1988). It can be argued that technology refers to a set of machines (e.g., airplanes) and the skills required to operate them (e.g., piloting) and their organization into a system of production (e.g., flight schedules, operating manuals) (Thompson, 1967). The gendering aspects occur at several levels, from the construction of the machine itself (e.g., the computer language), to assumptions about who is capable of operating it and working within a particular system of operations. In each case underlying beliefs, values, and assumptions inform decisions about who is employed in the field, and these underlying dynamics can have far reaching implications for the gendering of the industry. This is no less so of the older aviation than the newer IT industries. In the next sections we illustrate the importance of organizational culture and gendered identities in women's IT careers.

ORGANIZATIONAL CULTURE AND WOMEN'S IT CAREERS

Information technology (IT) developed predominantly from the discipline of mathematics and has evolved over the last 50 years (Nash, 1990). Akin to the engineering discipline and its interrelationship within organizational cultures (Margolis & Fisher, 2002), IT developed into a male dominated profession with relatively few women in positions at any level of the organization (Truman & Baroudi, 1994). Gendering practices were evident based on the high distribution of males in managerial and analytic roles versus the high distribution of females in administrative support roles. Focal positions within the IT environment included roles such as programmers, architects, and systems analysts, which were chiefly occupied by males (Ahuja, 2002; Truman et al, 1994). Support roles such as system administrators, data entry, and administrative assistances were relegated to females (Ahuja, 2002). Thus, in the early evolution of the IT industry and profession gender discrimination was evident in the exclusion of women from the critical design and development roles, as well as senior leadership positions. These absences continue (MacInnis & Khanna, 2005) and are reflected in much of the language used in reference to computing (e.g., system crashes, hard drive, etc.) and the people who design them (e.g., geeks).

Work within the realm of IT is frequently perceived as being performed in isolation with little interaction required with other members of the department or the organization (Rola, 2003). This isolation, along with a relative mystique about computing, earned IT professionals the title of "geek", which is further supported by a software gaming culture shared by many within the profession (Klawe, 2001; Menagh, 1998; Palma, 2001). Imagery typically associated with IT geeks reflects a smart but "uncool" person (e.g., taped glasses, bow ties, pocket protectors) (Menagh, 1998). Further, efforts to retain and attract IT professionals in many organizations during the 1990s focused on creating organizational cultures defined by elements that advanced gender discriminatory practices (e.g., recreational areas with pool tables, basketball courts, and beer on tap, and provided employees with flexibility through causal dress, and bring your dog to work policies). Accompanying this atmosphere emerged a cyber language that transferred machine-like terminology to the human aspects of work, (e.g., the plug and play computer term equating to hiring), the cycle time of machines referring to human resource time available to do a job (Margolis & Fisher, 2002). As a result of these influences, the identity of computer programmers and designers became reinforced as a male profession and masculine pursuit in the development/presentation of the skills required, the symbolism reflecting those skills (e.g., the language, informal dress based on young males), and the associated social activities built around gaming.

While studies have shown an increase in women in IT roles such as system analysts and programmers since the 1970s, the overall results have indicated that the percentage of women in these roles has remained relatively constant (30% or less of the technical workforce in North America and Europe in 1996) (Ahuja, 2002; Richardson, 2004). Further contributing to this gender gap is the decrease in enrollment of women into computer science programs (Camp, 1997; Margolis & Fisher, 2002; Palma, 2001). On the surface concerns expressed by females considering computer science programs include limited number of females in classes, non-female orientated learning environments, perception of the "geek" factor, dissuasions by teachers and guidance counselors, and the gaming culture (Margolis & Fisher, 2002). Despite these dissuasive factors, studies have shown that women find different attractions to computer science and IT professions than their male counterparts. When considering an analytical role such as programming, males are more attracted to the role as it relates to success, creativity, control and problem solving, whereas females are more attracted by success, problem solving, challenge, and math related aspects. These differences point to changes in both university program curriculums and learning environments, and organizational cultures in order to attract and retain women into predominantly male IT roles. In other words, they suggest a need to address the way that IT organizations develop their organizational cultures to both attract/retain women and men but also to encourage more women to enter the business in the first place.

CONNECTING WOMEN IN IT

Women respond to male-dominated organizational cultures through a variety of approaches, including the development of female associations or networks (Mills & Murgatroyd, 1991). Within the IT discipline, women have taken advantage of the new information communications technologies (ICT) to develop associations and support networks to reach beyond organizational boundaries and create associations in "cyberspace" (Lahey, 2002). These female-centered formal and informal networks are aimed at encouraging and promoting IT as a profession for women and developing effective networking and mentoring relationships for women across industries and IT interests (Ahuja, 2002). Networks such as GirlGeeks, Anita Borg Institute, Women in Technology International and Women's Networking Support Programme provide a variety of services such as education about careers in IT, promotion of women through networking and mentoring into new positions and/or companies in IT, and support social implications for future ICT developments.

CONCLUSION

Organizational culture continues to play a pivotal role in perpetuating gender practices and identity stereotypes within the IT discipline. Simple but profound remedies can be taken throughout IT education and operations to examine and address the extent to which such things as underlying belief systems, values in use, dress, language, symbolism, and processes throughout the industry reflect distinctly masculine or feminine associations. Females will not be drawn into the industry by opportunity alone, as vital as that is, but by feeling or sensing that it is not a narrowly drawn masculine culture (Helms Mills & Mills, 2000).

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KEY TERMS

Anita Borg Institute: An IT professional network for women. Provides a platform for women to express and influence the future of technology. This network is a blend of industry professionals and academics (http://www.anitaborg.org/).

Cyberspace: A term used to refer to the virtual connection provided through on-line capability on the World Wide Web (www) that provides a platform for communication, information, transaction, and entertainment.

E-Business: The process of doing business with either consumers or other businesses through electronic transaction processes and portals.

Gender Identity: Refers to the regular association of certain characteristics with men and certain other (often opposite) characteristics with women. These associations revolve around notions of sexuality and are often assumed to characterize particular types of men and women.

GirlGeeks: An online communication network for women and girls focused on providing information regarding computing and IT education and careers (http://www.girlgeeks.org/).

ICT: Information communication technology. The term refers to the proliferation and convergence of computing and telecommunications technologies that network to provide communication capabilities.

Organizational Culture: (a heuristic for studying) the configuration of beliefs, values, and assumptions that influence organizational practices and associated feelings and emotions.

Women in Technology International: A global women's network focused on providing support and mentorship for women in IT careers (http://www.witi.com).

Women Networking Support Programme: A global women's network focused on providing support for social change. A platform designed to assist women to influence the future design of information communication technology development and policy. (http://www.apcwomen.org/eng_index.html)

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Gender in Computer Science

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INTRODUCTION

Computer science (CS) is defined in *wikipedia* as a branch of human knowledge "relating to computation, ranging from abstract analysis of algorithms and formal grammars, to subjects like programming languages, software, and computer hardware" (Computer Science, 2005). Computer science emerged as a distinct field in the 1940s and 1950s with the development of the first electronic digital computers. To limit computer science to just computer use or its knowledge bodies, however, is reductive; CS is embedded in a complex, unquantifiable cultural context, including socio-economic and gendering practice. Computer hardware and software are designed to complement and supplement human activity and processes such as warfare, industrial applications, information management, including education, the Internet, a knowledge commons, and most recently biotechnology. Although CS is typically considered neutral and scientific, its episteme and practice is androcentric or male centered, often to the exclusion of females (Herbst, 2002). Female attributes have not typically been associated with computer science or computers. Although there is general agreement that women are as intellectually capable as men in CS, the fact remains that women today do not have equal participation in CS majors, CS engineering, programming, software design, Web site construction, or computer repair. (Jepson & Perl, 2002). In the technetronic 21st century, when computers are becoming standard for education and in symbolic analytic jobs, women's enrollment in CS has declined, and many women do not feel confident using computers for more than e-mail transmissions, e-commerce, and social interaction in forums or newsgroups. Women who do not have knowledge or confidence in their abilities to work in CS not only have unrealized potentials in CS but also are left out of employment activities. Reasons for gendering in CS are complex and debated. Socialization, overt and tacit discrimination, and epistemological plurality are three dominant explanations. CS industries, educators, cognitive scientists, parents, and women professionals in CS are some of the groups currently working to attain gender equity in CS.

BACKGROUND

CS is typically viewed as abstract, formal, logical, and objective with strong connections to mathematics. Viewed from a gender perspective, however, CS is androcentric in origin, product creation, and product dissemination. (Herbst, 2002; Littleton & Hoyles, 2002) CS scientific and technical research did not simply follow from a eureka; CS technology research and development in the past and present reflect the priorities of American male political and economic elites and their international allies. Computation and CS are creations of the military, the communications industry, and academic science. Computer graphics imaging (CGI) for example, originated during WWII with radar technology, and lexical constructions from this military *paterfamilias* still exist, such as *execute*, *terminate*, and *abort*. Cutting edge CS research continues today in the military, private industry, and academic institutions. Prominent among them: Naval Research Laboratories; XEROX's Palo Alto Research Center; Sun Microsystems; Microsoft; Stanford University; and Carnegie-Mellon University. Although CS applications still reflect the priorities of private industry and the military, the Internet, originally a military-scientific database, is now available to the public. As a communication and knowledge commons, the Internet is a major tool for participation in CS and electronic culture in the 21st century.

Just as the knowledge base of CS is predominately androcentric, so, too, is the culture and practice of CS, which is revealed in a number of ways: male dominance in CS professions: CS product manufacturing for public consumption, exemplified by the computer gaming market; CS journals, such as those published by the Institute of Electrical and Electronics Engineers (IEEE); CS print media geared toward CS career people with *Wired* magazine as one notable example; mass media images of CS products and practitioners, such as advertising; and male dominance on the Internet (Jackson, Ervin, Gardener, & Schmitt, 2001).

Popular print journalism and mass media are especially revelatory in terms of CS culture, real and imaged. *Wired* magazine, with its tech-speak and high-tech graphics, is interesting in terms of what it reveals about the qualities of androcentric CS culture. Geared towards an educated, affluent male readership, although 20% of *Wired* readers are female, the magazine has a predominance of hacker jargon, sexually appealing cyborgs and avatars (Wolf, 2003), and an aggressive tech-speak style that is the patois of the male CS culture. Beliefs and mythology of CS and "cyber religion" are also evident. Male computing, for instance, is expressed as a macho territory with the hacker as rebel. What is also evident in *Wired* is that CS and its language builds connections among men (Margolis & Fisher, 2001), which, in turn, provides men with the CS social and cultural capital that is useful for building and maintaining professional careers. Stereotypical CS images in other forms of mass media also extend the pervasiveness of androcentric CS culture. Analysis and deconstruction of mass media images in advertising, video games, and film reveals gendering of techno-culture. Advertising, for example, promotes stereotypes and also proselytizes the manly heroics of CS activities and careers. Frontier metaphors are often applied to CS activity: freedom, self-determination, profiteering, and egoistic individualism. These stereotypes and images eventually become part of the tacit knowledge of society and people's conceptions about CS culture.

Androcentric CS culture is also evident on the Internet, a knowledge, and communication commons and a circuit for e-commerce transactions. Although use of the Internet by females has increased dramatically in the last few years, females still use the Internet less and in different ways than males. The Internet is predominantly a male terrain reflecting male values and interests, such as the proliferation of sexually explicit material (Barron & Kimmel, 2000). Although a recent report by the European Union claims women have overtaken men in Internet usage, with women ages 55 and older increasingly gaining computer skills (European Union Commission Staff, 2005), the report, *eInclusion Revisited: the Local Dimension of the Information Society*, indicates female computer use is social in nature, mainly comprising e-mail to family and friends. Women may surpass men in e-mail use on the Internet, but males pervade in all other areas: Web site design and administration; information retrieval; recreational, academic, and professional discussion boards and forums; blogging; and wikis.

The professional and occupational practice of CS is also androcentric, although socio-economics, education, and family socialization can qualify an individual woman's participation in CS (Rajagopal & Nis, 2003). Although occupational employment predictions for the early 21st century indicate a high need for people with CS degrees (Hecker, 2001). Only 27.7% of bachelor's degrees awarded in CS in the U.S. are earned by women (Freeman, 2004), and women terminate their degrees earlier than men, earning fewer advanced degrees in CS. When women do find employment in the technological field, generally they are in gendered positions such as data-entry clerks or "keyboard operators" while men hold the higher paying and higher status positions such as analyst, programmer, and engineer. Even when women do work as analysts and engineers in CS industries, they admit to feeling less comfortable in the terrain than their male peers, even though they have the same proficiency (Moskal, 2002).

In general, women have lower level of participation in digital culture, although there is agreement they are as capable as men intellectually. What is the explanation for this?

Gendering in CS is a complex issue with many differing arguments and no consensus (Clegg, 2001; Gunn, McSparren, Maclead, & French, 2003; Jackson et. al, 2001). Three dominant explanations are socialization, discrimination, overt and tacit, and epistemological pluralism.

GENDERING IN CS: SOCIALIZATION

In Western middle class educational settings and home life, CS enculturation is evident at an early age. (Herbst, 2002; Jenson, de Castell, & Bryson, 2003; Littleton & Hoyles, 2002) Boys, both at home and school, are generally given more access to computers than girls. Numerous other socialization factors also dissuade girls from computers: the lack of positive role models in mass media; the dearth of positive adult female role models in math, science, and CS; and the negative stereotype of *geek* and *nerd* in peer culture. Toys and games also serve to reinforce this division, especially since computer games typically have been created and manufactured for boys, reflecting an adolescent male culture with themes of war, crime, and male-oriented sports. *Duke Nukem 3D* is one favorite among boy gamers. Even when software is designed for both males and females, as with mathematics software, the slant is still towards a male user-group. Mattel's *Barbie Fashion Designer* is one example of the types of games produced especially for girls, and these software games are questionable on a number of counts. For one, games such as *Barbie* emphasize fashion sense and physical appearance, and there is concern about the unrealistic standards of beauty and body images that these games reinforce. Two, there is question about the low level of skills entailed, since these games do not develop eye-hand coordination or computer proficiency. Although *Barbie* has been a big seller, girls have demonstrated they also like complicated games involving problem solving and intricate plots, evidenced by the popularity of *Myst* among girl gamers.

The message girls receive from this enculturation is that computer skills are not important for them to function as women in society; furthermore, computers are perceived as being connected with male activities. These attitudes persist into the future, as studies show early experience with computers and computer games informs use pattern in adult life. (American Association of University Women (AAUW), 2000). Many men in CS when questioned will say they became interested in computers through gaming. In addition, CS self-evaluation and self-perception, often acquired in childhood, can influence performance in CS later in life. (Yee, Hsich-Lee, Pierce, Grome, & Schantz, 2004). In other words, having CS confidence is important for success with CS, yet because of early socialization, many girls lack the required intellectual self-esteem. This confidence pattern continues into secondary education, where girls do not generally participate in computer science classes or computer activities, even though they successfully complete more advanced placement (AP) courses in math and science than their male cohorts (Gunn et al., 2003). The result: girls and young women use computers for communication, such as e-mail, whereas boys and young men, who also use the computer for e-mail, additionally utilize computers for games, program downloads, and information retrieval (Jackson et al., 2001; Jenson et. al., 2003).

By the time women encounter CS in post- secondary education or college, they are already aware of its androcentric components from past socialization, and the effects of this socialization become evident. College women still persist in the view computers are not important and even express concern about health risks associated with computer use (Jackson et al., 2001). Stereotyping of individuals who pursue CS also prevails, such as computers are only for smart people or computers are for people who do not like to work with other people. Often, women students do not even know what CS entails, thinking that it is mainly programming, which does not generally appeal to women.

When women enroll in post-secondary CS classes, though, they do just as well as men. Many female students take CS classes with little computer experience, yet they do well and their self-confidence in their computer abilities increases the longer they remain in CS courses (Cohoon, 2002). This evidence counters the idea that prior computing experience is necessary to do well in undergraduate computer science. College CS classes also reveal there is a gap between women's perceived CS ability and their actual performance. Although on average, male proficiency in Web page construction and even word processing (Rajagopal & Nis, 2003) is stronger than female proficiency, when it comes to CS courses, women do just as well as men, even though men express confidence and women express self-doubt (Margolis & Fisher, 2001; Yee et al., 2004). Despite success in CS courses, however, most women do not consider CS as a major or a career choice, and women students continue to concentrate in fields that historically have been dominated by women, such as education. (Freeman, 2004).

GENDERING IN CS: DISCRIMINATION

Research indicates that socialization is only one factor in the gendering of CS. Another is discrimination, overt and tacit, that deters women from CS and supports the status quo of androcentric culture. Overt discrimination in terms of exclusion, sexism, and harassment is well known, and statutes are now in place to help protect women from sexual discrimination. Less recognized and harder to identify, however, is tacit discrimination resulting from the gendering of all institutions in society, making self-realization, and functioning more difficult for women (AAUW Educational Foundation, 2004; Margolis & Fisher, 2001). Tacit discrimination begins early in life. Family socialization and early education de-prioritize CS skills and knowledge for girls. In college, tacit discrimination comes in various forms, such as no safe access to terminals at night in study areas; lack of female professional role models; insufficient mentoring in CS departments; and an exclusive "hacker elite" in CS departments with its own patois and supportive male network. Furthermore, women, who still perform much of the work entailed with family and children, along with work outside the home, have little time for computer activities such as blogging and are often last in line for using home computers, since typically children and husbands have priority access to home computers. (Kramer, 2001).

Tacit discrimination toward women is also evident in technology industry careers, although the CS industry is concerned about workforce issues relating to the absence of women in CS (Academic Innovation Group, Microsoft Research, 2004) and is keen to increase women in employee ranks. Women generally do not feel comfortable in corporate CS environments, however, and many end up leaving. Common reasons: the lack of female mentors and role models; the necessity of working harder than male peers to receive comparable pay; the experience of slower promotion patterns; and the stress due to juggling career and family obligations in a profession that expects 60-plus hours a week (Moskal, 2002).

GENDERING IN CS: EPISTEMOLOGICAL PLURALISM

Along with socialization and discrimination, a third explanation for the low level of female participation in CS is epistemological pluralism. According to this explanation, women, although just as intellectually capable as men in CS, are not generally comfortable with traditional CS episteme or CS curriculum in higher education that prefers well-delineated sub-procedures and logical thinking (Dodig-Crnkovic, 2003). Men in CS, on the other hand, are more comfortable with the traditional CS intellectual terrain. For example, men in CS generally like commanding and planning abstract formalities, such as in programming, which is viewed as a mathematical expression. Women, in contrast, do not generally care for programming in and of itself; instead they prefer to approach computing creatively and artistically, allowing patterns, effects, and meanings to emerge. Furthermore, while men claim intrinsic interest in CS is a major factor for their involvement in the field, women typically become interested in CS for a different reason. For women, the computer is a tool to use within a broader context of other fields, such as medicine, education, and community work. Many women, in other words, approach CS and computers from a different perspective than androcentric CS, and because women assume this difference is wrong or substandard, they are reluctant to pursue CS (Gunn et al., 2003) in education and careers.

Research by scholars in CS, education, cognitive science, and feminist studies on women and CS (Dodig-Crnkovic, 2003; Mortberg, 2003; Sorenson, 2004) demonstrates, however, that the female perspective on CS is not wrong. Instead it is one form of CS epistemological plurality; it is a different but equally legitimate way of knowing and practicing CS. Asking questions such as *What implicit assumptions and commonly accepted views underlie knowledge processes in CS?* these researchers not only reveal androcentric bias in CS and western science (Dodig-Crnkovic, 2003), but they also reconceptualize women's computer skills as *real* computing, not makeshift or second-rate (Dodig-

Crnkovic, 2003; Mortberg, 2003; Sorenson, (2004). Interestingly, these scholars also demonstrate that despite the perception of CS as a scientific and neutral branch of knowledge, CS has another intellectual side: nonmathematical and nonscientific. The computer, with its graphics, its sounds, its text, and its animation, can provide a knowledge creation tool and artistic medium for people whose chief ways of relating to the world are kinesthetic, visual, and artistic-intuitive (Dodig-Crnkovic, 2003; Mortberg, 2003). Research in CS epistemology and women's ways of knowing has already led to changes in software design and CS curriculum in education that helps alleviate women's intellectual alienation in CS (Margolis & Fisher, 2001). Nevertheless, androcentric perspectives and priorities still predominantly inform the instruction of CS and the development of computing innovations and the CS knowledge base. Unless there are major changes, CS is likely to remain a "male clubhouse" (Margolis & Fisher, 2001).

FUTURE TRENDS

Educators, the CS industry, cognitive scientists, women professionals in CS, and parents are aware of the gender inequities in CS and are attempting to remedy the situation in various ways (Academic Innovation Group, Microsoft Research, 2004; Ben-Ari, 2004; Cohoon, 2002; Mortberg, 2003; Sorenson, 2004). Along with parents advocating for equitable CS socialization for their daughters, various organizations today are making a concerted effort to encourage CS education for girls and women. GirlTech; Digital Sisters; Committee on the Status of Women in Computing; and the American Association of University Women are four notable organizations who approach the issue through education. Women's CS professional networks are proliferating today to assist in not only educating women in CS but also promoting CS careers and building networks with other women. Three such professional organizations are Women in Computing; Systers; and Women in Technology International. Industry leaders in CS, such as Microsoft Corporation, are working to increase the presence and retention of women in CS in their corporate culture. Acknowledgment of epistemological pluralism in CS has led to recreating intelligence in CS that is radically different from the logic-based approaches that have been dominant in computation. By recognizing multiple human intelligences and multiple CS intelligences, researchers are working to offer all CS learners and users a rich intellectual laboratory and vehicle for self-expression and knowledge creation (Ben-Ari, 2004).

CONCLUSION

CS, although considered a mathematical, logical, and neutral field of human knowledge, is a gendered terrain. Computer hardware and software are major knowledge tools in the early 21st century, and educated use of these tools, along with access, determines who may participate in a digital society. In first world countries, affluent and middle class women are minor participants in all CS areas, except e-mail use, e-commerce, and social interaction on forums and discussion groups. This gender digital divide is due to many factors, namely socialization, discrimination, and epistemological plurality. CS industries in western countries view the scarcity of women in CS as a workforce issue, but it is also important to consider female under-representation from an ethical perspective for two reasons. First, gender equity in CS is a worthy goal because barriers and stereotypes limit both sexes. Second, gender equity in CS is necessary because all should have access to the economic, social, and intellectual benefits of CS culture. Educators, CS industries, cognitive scientists, professional women in CS, and parents are some of the groups working to achieve CS gender equity in society.

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KEY TERMS

Avatar: An icon or representation of a computer user in a shared virtual reality, such as a MUD (*multiple user dimension*, *multiple user dungeon*, or *multiple user dialogue*).

Blog: A Web site that contains dated entries in reverse chronological order (most recent first). Blogs can be written by one person or a group of contributors. Entries contain commentary and links to other Web sites. Images, audio, and a search feature may be included**.**

Computer Science (CS): A branch of human knowledge relating to computation. The Computer Society of the Institute for Electrical and Electronic Engineers (IEEE-CS) and the Association for Computing Machinery (ACM) identify fourteen CS bodies of knowledge: discrete structures, human-computer interaction, programming fundamentals, graphics and visual computing, algorithms and complexity, intelligent systems, programming languages, information management, architecture and organization, software engineering, operating systems, social and professional issues, net-centric computing, and computational science.

Cyborg (Cyber and Organism): Describes any organism that has been augmented with technology.

Epistemological Pluralism: A phrase adopted from Turkle and Seymour (1990):

Although the computer as an expressive medium supports epistemological pluralism, the computer culture often does not. Our data points to discrimination in the computer culture that is determined not by rules that keep people out but byways of thinking that make them reluctant to join in. (Turkle & Papert, p. 133)

Symbolic Analytic Jobs and Symbolic Analysts: Defined by Robert Reich (1992):

Symbolic analysts solve, identify, and broker problems by manipulating symbols. They simplify reality into abstract images that can be rearranged, juggled, experimented with, communicated to other specialists, and then, eventually, transformed back into reality. The manipulations are done with analytic tools, sharpened by experience. These tools may be mathematical algorithms, legal arguments, financial gimmicks, scientific principles, psychological insights about how to persuade or to amuse, systems of induction or deduction, or any other set of techniques for doing conceptual puzzles. (pp. 176-177)

Technetronic: Related to or characterized by the changes effected by modern advances in technology and electronics (Brzezinski, 1970).

Tech-Speak: The formal technical vocabulary of programming, computer science, electronics, and other fields connected to hacking.

Wiki: A Web application that allows multiple users to add content while also allowing anyone to edit the content. Collaboration is an integral feature.

Gender in Distance Education Technology

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INTRODUCTION

Distance education is defined by six pedagogical elements: (1) physical separation of teacher and learner; (2) regulatory function or influence of an educational organization; (3) media to connect teacher and learner; (4) two-way communication exchange between teacher and learner; (5) individualized pedagogy instead of group focus; and (6) "industrialized" facilitators, entailing less individuated instructors (Keegan, 1980). Distance education technologies include video (videotape, satellite delivery, microwave delivery, broadcast video, and desktop video), computers (e-mail, Web-based courses, video conferences, DVD, and CD-ROM), collaborative activity software (chat, discussion rooms, and white boards), voice /audio technology (telephone, voice mail, audio conferences, audiotapes, and radio), supplemental print material (books, study guides, workbooks, and FAX), mobile technology (laptop computers, PDAs, tablet PCs, and cell phones), and blended-learning combining one or more of these delivery methods together, including face-to face instruction.

Distance education technologies as tools are situated in the larger context of technological and scientific knowledge, economic institutions, including the property and market institutions of capitalism, and social institutions, such as education, which historically has been unequal and exclusionary due to class structure and the system of gender and racial power relationships (Carroll & Noble, 2001). People barred or deterred from regular access to education in various ways have always been users of distance education technologies, starting with its inception as correspondence course education in the 19th century and continuing today in high tech distance education classes with women comprising the majority of enrolled students (Hansen, 2001; Ossian, Christensen, & Rigby, 1968).

The promise of distance education technologies in the 21st century is for empowerment of students through democratization of knowledge, personalized pedagogy, and convenient access. Despite the promise and the current high enrollments in distance education courses, attrition rate is high in North America and Europe (Carr & Ledwith, 2000; Serwatka, 2005), and this is a concern to educators and social policy makers, who search for reasons to account for the discrepancy between promise and practice. While recognizing men students have high attrition in distance education courses, too, the fact is women comprise the majority of distance technology users. If educators and policy makers hope to use distance education technology to reach female students (and garner the interest of more male students as well), then issues of gender in distance education technology need to be addressed. A female gendered perspective on distance education technology reveals a number of variables that explain women's disengagement and dissatisfaction with online educational delivery systems. Educators, secondary education institutions, and instructional software designers are some of the groups working to create and implement inclusive, constructivist, and rich multi-media instructional design (McLoughlin, 2001) that will accommodate a wide range of learner needs.

BACKGROUND

Educational technology associated with distance education reflects the evolution of human institutions and inventions, starting from mail delivery and evolving to CD-ROMs and PDAs. From its beginning in the 19th century, distance education stemmed from a scarcity of educational resources in an era with more rigid class and gender definitions than in the 21st century (Carroll & Noble, 2001; Gandle & Katz, 2004). Distance education, first known as *correspondence education* because course materials and lessons were conducted using the postal service, was directed toward nontraditional, under-privileged and disadvantaged groups who did not have economic, geographical, or social access to education. Correspondence course users included people who were poor, rural, intellectually gifted, and female. In the U.S., distance education was modeled after European correspondence education, such as the program started by Isaac Pitman in Great Britain offering shorthand instruction. In 1892, the University of Chicago established a school of correspondence study that raised the reputation of distance education as an institution in the U.S. Most distance education schools in the United States in this time period were not the caliber of the University of Chicago, however. Often advertising their educational programs on matchbook covers, hence the derogatory appellation *matchbook colleges*, these schools were considered inferior to traditional education and often were second-rate and even charlatan. With the 20th century advent of new technologies, such as radio and television, however, correspondence education in general took on other forms and its respectability began to improve. As technology continued to evolve, using audio cassettes, video cassettes, cable television, and tapes, so, too, did correspondence education. The modern stage in correspondence education began in the 1970s with the creation of Open University in Great Britain, where print instruction was supplemented with audio-visual technology. Within this time frame, teleconferencing and computers began to be used as instructional mediums. In 1982, the International Council for Correspondence Education evolved into the International Council for Distance Education, and the term *correspondence course* dissolved.

Today distance education is a legitimate and mainstream pedagogical practice in K-16 education and employee training. Many educators, business leaders, and policy makers are firm in the view that, there is no significant difference in asynchronous learning networks (ALNs) from university (*brick and mortar*) settings in terms of learning outcomes (Allen & Seaman, 2003). Currently, in the early 21st century, distance education, along with its various technologies, is an integral part of education, specifically, higher education services, which are projected to reach 160 million students by 2025 (Hansen, 2001).

WOMEN AND DISTANCE EDUCATION TECHNOLOGY

Women have taken advantage of distance education from the 19th century, when, in an era of educational rationing, depending on class, sex, and race, people were denied access to higher education and professional education. (Carroll & Noble, 2001). Now in the 21st century, women are the dominant user group of distance education, although they no longer depend on the postal system for delivery of course material. Instead, the computer is the major distance education technology with instructors utilizing various ALNs or course management systems (CMS), such as WebCT, Desire2Learn, and Blackboard, which allow students to access classes anywhere and any time they have Internet connection. Some instructors create their own CMS by placing material on their own individually designed Web sites, often with *a la carte* features added, such as discussion boards and chat rooms. The computer skills students need to engage with any of these courses are minimal. Orientation to the online environment is a major requirement, but once this is accomplished, a good deal of activity on the computer entails keying in text and handling the mouse. Although technical difficulties may intrude from time to time, most CMS are user friendly and designed to be problem free.

Despite women's long history as distance education students and user-friendly CMS, female interaction with distance education technology, specifically computers, is problematic. Generally, women lack confidence with computers and are anxious about encountering technical difficulties, although, ironically, they are more successful in completing online course than men, who tend to have greater confidence and proficiency with computers (Parker, 2003; Serwatka, 2005; Taplin & Jegede, 2001). Attrition in online education is high for women, and many express dissatisfaction with their online learning experience. Men students also experience high levels of attrition and dissatisfaction when it comes to distance education; however, given that the majority of distance education students are women, educators, cognitive scientists, and educational software designers are especially interested in determining why women are not more enthusiastic users of distance education technology. Research suggests a number of gender variables influencing women's attachment and detachment to distance education technology, all of which contribute to an inequitable and unsatisfactory learning experience: computer socialization, which includes diversity issues; tacit discrimination; androcentric dominance online; lack of support structures for successful course completion; and poorly designed online courses.

COMPUTER SOCIALIZATION

In Western middle class educational settings and home life, gender enculturation in terms of computers is evident at an early age. At home, boys are generally given more access to computers than girls, who instead will often watch males in their households use computers. Toys and games also serve to reinforce this gender divide in computer use, especially since computer games typically have been created and manufactured for boys. Although the educational value of computer games is contested, research indicates gaming does accustom boys to online environments, allowing them to become accustomed to navigating through games and online sites and using discussion boards and forums to locate cheat sheets and build competencies in gaming, programming, Web site development, and technical troubleshooting. Consequently, before adolescence, boys can have keyboard dexterity and technical proficiency that will be helpful in future course work and computerized instruction.

The socialized gender divide in computer acclimation becomes more evident in middle school and high school, where girls, even though enrolled in more advanced placement (AP) classes than boys, are not active in computer science classes or clubs. In post-secondary education and college, this pattern persists. Computer science (CS) in college and career choice is a largely male terrain with women earning a low percentage of the bachelor's degrees awarded in CS in the U.S. Women who do take computer courses in college terminate training much earlier than males; women with CS degrees earn fewer advanced degrees. Socialization, social expectations, and cultural metaphors all guide these choices. (Palmieri, 2004; Rajagopal & Nis, 2003). Girls who are not comfortable with computers grow up to be women who are apprehensive about computer use and this attitude affects their experience of distance education courses, even when they enter or exit courses with the required competency in computer use (Fisher & Margolis, 2002).

DIVERSITY

Although women in a gendered world have some historical and social experiences in common, there is no uniform female experience, and any examination of women's interaction with distance education technology must acknowledge the diversity of women's lives (Carr &Ledwith, 2000). Socialization with regard to computers and computerized instruction, then, is qualified by differences in each woman's personality, family socialization, class, and ethnicity, (Hayes & Flannery, 2000). Women who have multiple cultural identities, such as Spanish American and Asian Americans, often experience conflicting demands and expectations from two cultures, adding another variable to gender and distance education technology. Some women, for instance, depending on their ethnic backgrounds, find it difficult to provide critical commentary on written texts or written authorities, which makes distance education assignments requiring critical analysis difficult for them to fulfill. When it comes to working poor and underclass women in the U.S. and first world countries, these women, who often have not completed secondary education, have difficulty utilizing distance education technology because of economics and because electronic culture is unfamiliar in their social and educational milieus.

TACIT DISCRIMINATION

A more crucial factor involved with women's attitude and relationship with distance education technology is tacit discrimination that deters women from computerized instruction and computer use in various ways (Palmieri, 2004). The basic tenet of tacit discrimination, derived from feminist theory, is that men and women lead very different lives in patriarchal societies; gender as a system of social organization and social relationships has effects on learning and knowledge acquisition (Hayes & Flannery, 2000) and makes self-realization and functioning in society more difficult for women. Unlike blatant sexual discrimination, which is now mitigated by statute law, tacit discrimination is unconscious and subliminal in terms of its gender discrimination, making it a difficult to recognize and surmount.

One example of tacit discrimination in relation to the gendering of distance education technology is educational institutions not providing safe access to campus computer labs at night, which dissuades women from computerized instruction. Another example of tacit discrimination toward women using distance education technology is the failure of institutions and instructors when planning educational programs or designing courses to take into account that school work for many women entails a "third shift" in their lives, along with the first shift of childcare and family responsibilities and the second shift of paid employment (Kramarae, 2000). Although some men students also work a "third-shift" in terms of child care and family responsibilities, statistically women in society still perform a majority of third-shift work. The burden of this third-shift creates not only work overload and increased stress but also anxiety about failure. As a result, many women withdraw from distance education courses or do not successfully complete them.

ANDROCENTRIC DOMINANCE ONLINE

Another factor contributing to women's dissatisfaction with distance education technology and online instruction is the dominance of men in CS and digital culture. Predominantly, computers and the Internet are male terrains, although women use computers and the Internet for e-mail transmissions, social interaction on discussion boards and forums, and e-commerce (Fisher & Margolis, 2002). Computer hardware, software, tech-speak, and online communication comprise an androcentric or male centered world that does not overtly bar women, but it does not always encourage their participation or engagement. For example, in Internet communication, whether forums, discussion boards, or chat rooms, male dominated speech prevails: aggressive, blunt language; harassment; flaming; and combative, sexualized jargon.

This male patois in electronic culture carries over to distance education technology in chat rooms, discussion boards, and class e-mail transmissions where men tend to dominate communication (Jackson, Ervin, Gardner, & Schmitt, 2001). When women encounter male classmates online with these behaviors, similar to traditional classroom dynamics, the learning environment is perceived as non-nurturing and hostile, causing self-doubt and silence. Research shows that male verbal dominance in online class environments takes many forms, all of which make women feel unwelcome: indicative, imperative, and agonistic verb moods; intentional and unintentional patronizing language; dismissive and hostile comments; and vulgar speech. In this verbal environment, women often feel alienated, consider themselves as outsiders, and are disinclined to further their education using distance education technology (Jackson, et al., 2001; Taplin & Jegede, 2001; Vuorela & Nummenmaa, 2004).

LACK OF SUPPORT STRUCTURES

Still another reason for women's disengagement from distance education technology is lack of support structures for successful pursuit of educational goals. Lack of support falls in to five categories: institutional, occupational, peer, instructional, and familial, all of which men in distance education courses experience as well. Because distance learning differs from conventional learning primarily in terms of student isolation and self-discipline, it is important for students to have support structures that enable them to successfully engage with the course material (Serwatka, 2005; Taplin & Jegede, 2001). Problems develop for students when these support structures, for various reasons, are not in place.

Lack of institutional support results when campuses operate as if they only have traditional students to service, such as when offices and college services are not open in evening hours. Occupational support systems fail when employers, who are generous with oral encouragement and financial support, do not follow through in terms of flexible work hours that would allow completion of class work. Peer support structures founder when students feel isolated from other students in the class, both in terms of physical presence and communication lines. Although women typically do well with the self-regulation and independent study required in distance learning, the social isolation from other students is difficult for them (Moore, 1993; Parker, 2003; Serwatka, 2005). Lack of instructional support takes the form of unreceptive, unresponsive instructors who do not respond to e-mail in a timely manner. Close contact with online instructors is another crucial factor in whether women gauge their online experience as meaningful and worthwhile (Serwatka, 2005; Taplin & Jegede, 2001). Finally, lack of familial support also hinders women distance education students. Although women generally like the convenience of working from home and not having to commute, home life does not always nurture educational effort, and psychological or emotional support from family members is absent (Kramarae, 2000).

PEDAGOGICAL SHORTCOMINGS

Questions about women's attachment to and detachment from distance education technology leads to questions about the quality of the pedagogical theory and design informing the technology as well as the quality of teaching by online instructors. How do designs and practices of distance education technology affect women learners' experiences? Distance education practitioners suggest five criteria for quality distance education instruction and delivery: facility with delivery and access; learner control over the medium, including adequate skills for human-computer interface; a high degree of interaction, not only between teacher and learner but learner and learners; a rich multimedia learning environments, utilizing audio- visual material; and a strong social presence in the course (Short & Christie, 1976).

Examination of these criteria reveals that, the major distance education technology in use, the computer, is not the problem, even though women experience computer anxiety. Distance education course design, content, and teaching practice, however, do fail to live up to the suggested criteria. Traditional pedagogical frameworks, similar to onsite lecture courses, still predominate in online instruction. Too often, course material is nothing more than classroom text and notes transplanted online (Allen & Seaman, 2003; Lee & Owens, 2000). Additionally, many courses are designed using a middle-class male episteme or knowledge framework, which alienates many students (Moore, 1993; Serwatka, 2005; Tisdell, 2000). Online teaching is also lacking. Many online courses lack strong social presence and have low levels of instructor-student and student-student interaction (Hayes & Flannery, 2000; Moore, 1993). Consequently, men and women students both are disenchanted with their online educational experiences.

FUTURE TRENDS

Educators, instructional designers, and educational institutions are aware of the factors impacting women's experience with distance education technology and online instruction, and, accordingly, they are making efforts to correct weaknesses and deficiencies. Elementary and middle schools are requiring girls to be computer literate as well as literate in digital culture, and educational and recreational software is being designed for girl students and girl gamers. All these efforts will nurture female computer confidence. Educational institutions are offering affordable day care facilities to accommodate women students with children; providing safe access to computer labs in evening hours, including security guard or buddy-system escort service to cars; and adding evening office hours for access to administrative offices and student counseling.

Educational and feminist theorists, aware of the importance in designing online courses to meet the needs of the target audiences and the needs of those who are at a disadvantage, whether from gender, ethnicity, or socio-economic background, are designing online classes that promote endogenous learning and knowledge construction for all students (Carr & Ledwith, 2000; Hayes & Flannery, 2000; McLoughlin, 2001; Palmieri, 2004; Tisdell, 2000). Emphasis is placed on universal and inclusive pedagogy in instructional design because it requires instructors and designers to place learners' needs first in the educational process and design courses for diverse student bodies. Implementing constructivist pedagogy in online instruction, which emphasizes the active participation of the learner, is also viewed as key in pedagogical reform (Weigel, 2001).

Online course designers and educators are also striving to take advantage and make use of rich multimedia software and utilities in online material (Billinghurst, Kato, & Poupyrev, 2001; Knemeyer, 2005; Lee & Owens, 2000), which will stimulate all the senses and intellectual faculties. These designers and educators are aware that more innovation is needed in online instruction, such as an electronic teaching theater that takes advantage of hypertext and multimedia and allows "depth education" (Weigel, 2001) that will engage and challenge students. Learning objects (Los), such as those available through *Project Merlot*—http://www.merlot.org/Home.po—can also be used to enhance online instruction.

Finally, educational institutions and instructors themselves are acknowledging that, distance education instructors, who are the key to making distance education technology and online instruction a positive experience for students, need training and institutional support on how be effective online teachers as well as how to design stimulating and challenging online content (Allen & Seaman, 2003; Moore, 1993). Accordingly, faculty development training in online instruction and effective use of distance education technology is now the new standard in post-secondary educational institutions.

CONCLUSION

Distance education technology has evolved a long way from the 19th century mail delivery correspondence system to computerized instruction. Statistics indicate women, the dominant user group, successfully complete distance education classes more than men; however, women, as do their male student cohorts, experience high attrition in distance education courses and express dissatisfaction with their educational experiences. There is no single factor responsible for female attrition, nonparticipation and discontentment; the reasons are multidimensional and complex: computer confidence socialization; diversity issues of race, ethnicity, and socioeconomic status, which qualify women's relationships to digital culture; tacit gender discrimination, such as "third-shift demands of childcare and family responsibilities on women; androcentric dominance online; support network absence; and pedagogical shortcomings in instructional content and instructors themselves. Improving women's experience with distance education technology begins with awareness of these factors and the acknowledgment that a woman-centered, learner-centered perspective by educational institutions, educators, and instructional designers is needed in order to make effective corrections. Approaching distance education technology from an inclusive perspective, along with applying constructivist pedagogy that is highly interactive and rich in multimedia will humanize and enrich online education for all learners—for men as well as women.

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KEY TERMS

Asynchronous Learning Network (ALN): An online method of instructional delivery that enables students to have the flexibility of learning at anytime from any location over the Internet.

Constructivist Pedagogy: A learning theory that contends learning should be an active process, whereby learners themselves construct new ideas or concepts based upon their current/past knowledge. Constructivist instructors encourage students to discover principles by themselves, and the instructor and student engage in highly interactive, Socratic dialogue.

Inclusive Pedagogy: See **Universal Design for Instruction (UDI).**

K-16: Refers to kindergarten through four years of college or post-secondary education.

Learning Objects (Los): Instructional modules that enable and facilitate the use of educational content online. Due to internationally accepted specifications and standards, Los are interoperable and reusable in various learning environments. (http://itdl.org/Journal/Sep_04/article02.htm)

Personal Digital Assistant (PDA): A handheld device that combines computing, telephone/fax, Internet, and networking features. Some PDAs can also react to voice input by using voice recognition technologies.

Social Presence: One of the most important factors for student engagement, collaboration, and retention in online learning environments. Social presence is the ability of learners to project themselves as real people and relate to the instructor and class peers socially and emotionally online. Formation of social presence for each student is not automatic; it must be nurtured and supported by the online environment and the instructor.

Tablet PC: A compact, portable device that incorporates many features of a laptop computer while also allowing learners to write lecture notes and save them electronically.

Tech-Speak: The formal technical vocabulary of programming, computer science, electronics, and other fields connected to hacking. (http://catb.org/~esr/jargon/html/distinctions.html)

Universal Design for Instruction (UDI)/Inclusive Pedagogy: An approach to teaching that consists of the proactive design and use of inclusive instructional strategies that benefit a broad range of learners including students with disabilities" (UDI Fact Sheet, 2002). (http://www.facultyware.uconn.edu/home.cfm)

Gender in Norwegian Computer History

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INTRODUCTION

"From the very birth of computing machines, women have made substantial contributions," according to Denise Gürer (2002). Augusta Ada Byron Lovelace wrote the first sketches for a computer program. Grace Murray Hopper constructed the first compiler, and the first electronic computing machine, ENIAC, was programmed by six women during World War II. When the computer first started to invade the market in the 80s, it fitted an image of women's work tasks: it was about handling a keyboard inheriting the typewriters place in office work, and it matched feminine qualities, like nimble fingers (Wajcman, 1991, p. 150). Female secretaries and office workers were among the first and most extensive user groups of computers. Yet, computer technology is regarded a male domain today, and the traces of women's contributions and participation are not easy to discover (Corneliussen, 2003a). This article presents a research project which looks for discursive traces of gender in debates about computer technology in Norwegian culture in the last decades of the 20th century.

BACKGROUND

Recent research on gender and technology has documented that the discourse of computing is dominated by a masculine norm (Corneliussen, 2003a, 2003b, see also Corneliussen, this book). The images of the "user" and "correct" use are tied to images of boys and men (Gansmo, Lagesen, & Sørensen, 2003). However, the link between men and computers is socially constructed, and there is no "natural" or essential about this link. Thus, it is important to ask, "how we got here." How has the discourse of computing developed in favour of masculine values and male contributions, making feminine contributions invisible?

This question calls for an analysis of the construction of cultural meaning related to the computer (cf. Berg, 1996; Lohan, 2000). The dominating theoretical perspectives in this project are inspired by discourse theory (Laclau & Mouffe, 1985) and the concept of domestication. Discourse theory provides tools for analysing construction of meaning[1], while the theory of domestication focuses on the co-construction of technology and culture in the process of adopting new technology in the household (Silverstone, Hirsch, & Morley, 1997 (1992)). A household has its own "moral economy"; routines, values and practices which are already established, and the new technology enters this "already filled" space. It is also possible to see Norwegian culture as an arena for domestication of technology (cf. Gansmo, 2004). New technology brings new elements into the culture, at the same time as it needs to be translated into the "moral economy" of culture, and to acquire meaning in and through already meaningful cultural stories (Pfaffenberg, 1988).

Norwegian culture is not homogenous. It is rather a series of different arenas, situations, and groups, and the domestication of computer technology might be different in different contexts. The main focus in this project is the construction of meaning which has taken place on the "surface" of society–the discourses in the public sphere. A variety of empirical sources are studied; the daily press, computer magazines and political documents with the intention of describing, controlling or shaping the status of computer technology in Norway. These various contexts have their own qualities, arenas, and institutions, but they also intersect with each other, and use each other as reference, "inter-discursive authority," or opponents in the debate.

The computer did not represent a new technology around 1980, still, something new happened: While computers had been a technology for those with a special interest or need prior to 1980, the development of "personal computers" in the beginning of the 80s made computers potentially available to more people and to different groups. Changes did not happen overnight, but this new availability marks a new era for public debates concerning the social and cultural meanings related to the personal computer. Historical studies of computer technology in this period in Norway have so far primarily focused on pioneers, entrepreneurs and the development of the technology itself. We know less about how these developments affected and were affected by the "main" culture, or the larger society, which is the focus of this research project.

As this is a work in progress, this article reports from the preliminary analysis of one particular computer magazine, *Datatid* ("Computer Age"). *Datatid* was published between 1979 and 2000 in Norway, and was one of the first and most important in this genre at the beginning of this period, while other magazines dominated the market later in the period. All (available) issues of *Datatid*, from 1979 through 2000, have been examined in order to single out material discussing the technology in relation to culture, society, social groups, or individuals. The next section will give some examples from the analysis of the "domestication" of the computer in the Norwegian culture as it can be seen through *Datatid*, with a special focus on how gender was involved in this process.

GENDER IN THE COMPUTER MAGAZINE *DATATID*

Even though *Datatid* aimed at an audience with an interest in computer technology, the magazine was clearly addressing an inexperienced computer market in the first part of the period. In the first issue in 1979, it was emphasized that the magazine was not for computer specialists, and the focus would not be purely technical, but would also include social perspectives on the technology (*Datatid,* 1979, no.1). In the beginning of the 80s, computer technology was discussed as a "revolutionary" technology causing a "new technological and social revolution" (*Datatid,* 1979, no.1), which would fundamentally change society, both in the private and the public sphere. The content of the magazine changed during the period, and in the last years of the publication it was dominated by a focus on technical matters. The debates about the "social construction" of the computer in the first decade illustrate that the technology had not yet acquired a "natural" position in the culture. Its position had to be defined, and it did not even have a proper name, according to *Datatid's* editor. New names and concepts had to be invented and the magazine initiated a name contest in 1979, asking readers to come up with a "better name" for the "Personal Computer" (*Datatid,* 1979, no.1). Several names were suggested, and one of them, "husdat," was even recommended by a language committee (*Datatid,* 1979, no.7). But it was not easy to "construct" a name for the new technology, and a wide variety of names were used in the magazine throughout the period, while the recommended "husdat" was only infrequently used, and disappeared altogether after 1983. During 1984 the concept Personal Computer (or PC) became a concept in use in *Datatid*, parallel with IBM's Chaplin commercials for the IBM PC, which became available in Norway in 1983 (Nerheim & Nordvik, 1986).

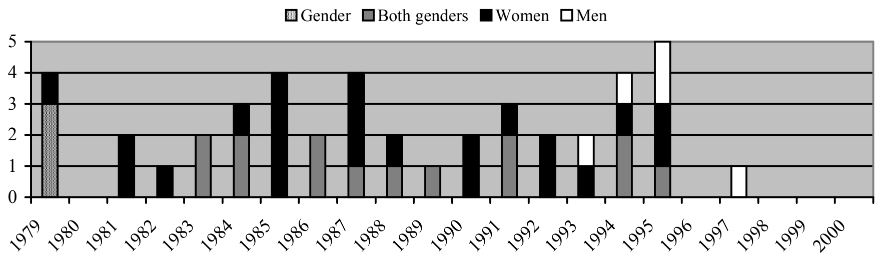
These examples illustrate that the technology was about to acquire a place in the culture in the 80s, a place that was not predefined, but had to be created in and through a collective process of domestication, which involved adjustments to Norwegian culture. During the 80s, the computer was frequently discussed in relation to work, school, education, and to all age groups. The discussions about the relation between society and technology concerned contexts and groups that involved both genders. However, in most cases, gender was not explicitly mentioned. In this article we will look at the cases where gender *was* perceived as an interesting category, and we could start by looking for the cases where gender was mentioned under various labels.

Occurrences of Gender Labels

In the period 1979-2000 there are 44 examples of gender being explicitly mentioned in *Datatid*, distributed as shown in Figure 1. The intensity of the debates concerning gender decreased in the last part of the 90s, similar to debates about the social or cultural perspectives on technology in general.

Figure 1 distinguishes between articles with the main focus on "gender" as an unspecific category, "both genders," "men" and "women."[2]

Figure 1. Gender explicitely mentioned in relation to gender, both genders, women, and men



- "Gender" as an unspecific category was found in three incidents, all in 1979.
- "Both genders" was brought into the debate 14 times, stretching almost throughout the period.
- Articles with a special focus on "women" clearly dominate the material, with 22 incidents.
- A special focus on "men" appeared in five articles.

This categorization does not bring us deep into the material, but it can illustrate to whom gender was perceived as an interesting category. The most striking difference is that women were "gendered," or discussed *as women*, more than four times as many as men were discussed *as men*. We need to go deeper into the material, but at this point we can perhaps assume that this has something to do with a phenomenon we can find in other contexts too, where women more often than men are made visible as gender (Lohan, 2000).

Gender Representations

If we go a bit further in the analysis of the gender representations, we can see that two of the three incidents in 1979, where "gender" as an unspecific category was used, were about programming as "something everyone can do, regardless of race, age, or gender" (*Datatid,* 1979, no.4 and no.5). In the third case, the "computer consultant" was discussed as a "he/she" (*Datatid,* 1979, no.4). In these three cases, gender was treated as an "insignificant" category related to computers, simultaneously as both men and women were explicitly included. This indicates that the computer had not yet become fixed in a masculine connoted discourse, but still had room for women. This interpretation can also be supported by the articles which focus on women during the 80s, where approximately half of them were discussing computers as the basis for a new career opportunity for women (*Datatid,* 1979, no.5, 1981, no.2, 1982, no.8, 1985, no.3, 1987, no.11, 1991, no.12). This theme disappeared after 1991, but the frequency of this debate during the 80s also strengthens the view that computers were not yet fixed as a "male domain." Quite the contrary, the computer was presented as a particularly positive resource for women because it appeared to free certain work tasks from the traditional office location. Women were expected to be bound to the home due to responsibility for family members in need of special care, and it was claimed that the computer could "give new opportunities to create more jobs for women near the home" (*Datatid* 1979, no.5). The computer seemed to promise something new for these women–those who could not enter the labour market on the same terms as men (and women) who were not "double workers."

The other topics in the articles focusing on women were more in line with the way "women and computing" has been discussed in recent years. A number of articles discussed the low proportion of women in computer education (*Datatid,* 1981, no.9, 1985. no.9, 1988, no.9, 1990, no.1, 1992, no.7-8, 1995, no.2), and a few articles focused on initiatives to increase girls' use of the computer in school (*Datatid,* 1990, no.1 and no.2, 1991, no.9, 1993, no.12, 1994, no.1). A number of articles focused on women because they were women within computer education (*Datatid,* 1995, no.2) or the computer business (*Datatid,* 1987, no.10, 1992, no.2). One example is an interview with a newly elected leader of the Norwegian Computer Society, which starts by asking, "is this a female takeover?" (*Datatid,* 1987, no.10). Even though the new leader had been active in the organisation for years and one third of the electors were women, her new position obviously made it "valid" to ask this question because she was a woman. Thus, on several occasions, gender became an interesting topic because women were unexpected within the computer business or computer education.

The 15 articles discussing both genders brought up different topics. One example from 1986 gave a humoristic description of the different computer users. Men were described with various relations to the computer, including the extreme and fascinated user, while women were portrayed as "restricted" and "pragmatic" computer users, a bit reluctant. While men also could be found in the same category as women, women could definitely not be found among the extreme (male) users, according to this article (*Datatid,* 1986, no.12). There is a tendency in the articles discussing both genders to see gender as a difference in terms of interest and use of the computer. And while it was possible to associate men with various relations to the computer, certain relations were impossible to associate with women.

A recurring topic in the articles discussing men was the computer fascinated young boys and men (*Datatid,* 1993, no.5, 1995, no.4 and no.8). Although descriptions of this group are not always positive descriptions, it nevertheless includes a special focus on boys' and men's computer competence. But also another group of men became visible in *Datatid*; the male leaders who suffered from "computer phobia"; men who did not use computers. While the first group of men has made important imprints on the present hegemonic discourse of computing, the last group has been more difficult to grasp. In 1985, a number of male leaders in IT companies were interviewed, and several of them strongly rejected that they needed a computer; the computer rather belonged in their secretaries' offices (*Datatid,* 1985, no.12).[3] The leader without computer competence is a recurring theme from 1979 (*Datatid,* 1979, no.2) through 1997, but gender is not brought into this discussion before 1997,[4] when it is made clear that only 2% of the participants in a survey revealing leaders (poor) computer competence, were women (*Datatid,* 1997, no.11-12). This rather large group of men without a relation to the computer does, however, not seem to have marked the hegemonic discourse the same way as the computer fascinated men have.

CONCLUSION

The findings from the analysis of *Datatid* can not without further investigation be generalized to the other empirical sources that are explored in this project. However, this brief look at the magazine gives an impression of how gender has been made visible (only) in certain situations and for certain groups. There are for instance some groups that do not seem to have affected the gendered images related to computer technology, and one such group is the female secretaries. They decorated several hardware and software ads, and many of the articles focused on office workers' use of computers. But female secretaries do not seem to have been perceived as an important user group in *Datatid*. One reason might be that at this point, there were differences between a "general" computer and a secretary's limited computer or a "word processing machine" (cf. Lie, Berg, Kaul, Kvande, Rasmussen, & Sørensen, 1984). Another reason might be that women's use of technology is not always regarded as "technological" as men's use of technology (Berg & Lie, 1995). The invisibility of female office workers as computer users might have caused an under representation of women's use of computers. Other threads where we could find positive descriptions of women's relations to the computer also disappeared before the mid-90s, like the computer as a special career opportunity for women, and programming as a gender neutral activity. Another group that did not affect gendered images is the male "non-users." In the previous example about leaders' "computer phobia," it was not the 98% male respondents who were gendered, but rather the 2% of female respondents. The male leaders largely remain "ungendered" leaders.

On the one hand, there was a tendency for women to become visible as gender in *Datatid* when the focus was on women's lack of relations to the technology. Men, on the other hand, were primarily made visible as gender when their special and intense relation to the computer was discussed.

Recent gender research has emphasized that there exists a plurality of masculinities and femininities (cf. Connell, 1995). There are several masculinities and femininities represented in *Datatid*, but only a few of them seem to have reached a discursive stability and become "available" subject positions.

From gender research it has also been claimed that gender "sticks more easily to women" (Faulkner, 2000), and that men maintain their hegemony because they are perceived as representatives of an ungendered norm (Lohan, 2000). However, men were gendered as computer users, and it can be claimed that it is precisely this gendering which causes the male hegemony within computing, because the negative stories about men's relations to the computer did not "stick" to men. Thus, the computer fascinated men were allowed to "represent" men.

The brief survey of this material illustrates how a detailed analysis of the public debates about computer technology might reveal hidden traces of gender in the history of computing. It can help to bring back to life stories about computer technology representing something special for women, as well as stories about male computer reticence, both of which can help to challenge the stereotypical images of gender and computing.

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KEY TERMS

Discourse: Within discourse theory (Laclau & Mouffe, 1985), a discourse is seen as a limited and temporarily fixed meaning within one particular area. A discourse is perceived as a fixed objectivity through "homogenisation of an interior" and "exclusion of an exterior".

Domestication of Technology: The theory of domestication (Silverstone et al., 1997 (1992)) emphasize that both the artefact and the household goes through changes and adjusts to each other when an artefact is introduced in a household.

Gender: In a poststructuralist perspective, gender is seen as a discursive category based on "perceived differences between the sexes" (Scott, 1988, p. 42). Gender is a historical and social construct that both explains and provides norms, rules, and guidelines for men and women.

Moral Economy: When new artefacts are introduced in a new context, this context is not an empty space, but has its own "moral economy"; routines, values and practices which are already established.

Social Construction of Technology: Social constructivist theories emphasize that society and technology shape each other in a simultaneous process.

Subject Position: In a discourse theoretical perspective, a subject position is a discursive point of identification within a discourse. The subject position gives guidelines for the individual, and the individual can either associate with or negotiate a subject position.

ENDNOTES

1. Read more about discourse theory in Corneliussen (2006)
2. This categorization is not unproblematic, and this will be discussed in another article from this research project.
3. The leaders' gender was revealed by photos and names, but gender was not explicitly mentioned, and this article is not included in Figure 1.
4. The articles discussing leaders' poor computer competence without mentioning gender are not included in Figure 1.

Gender Inclusion in the Information Society

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INTRODUCTION

Strategies of Inclusion Gender and the Information Society (SIGIS) was a European study exploring initiatives to include more women in the information society.[1] This article summarises its main conclusions. The work started from the premise that overall more women than men are excluded from the information society, both as users and as designers of new information and communications technologies (ICTs). Our literature review (Sørensen & Stewart, 2002) confirmed that there is still a gender gap in terms of ownership of some ICT products and, to a lesser extent, in terms of access and use. Gender cuts across other dynamics in the digital divide—income, occupation and age being generally more significant than gender—with other factors (e.g., ethnic minorities, lone parent families) also intervening. Although the trend with respect to the use of ICT products is one of a closing gender gap, it is clear that diffusion alone is not sufficient to close the gap all together; inclusion efforts are still warranted in this area. By contrast, the literature review revealed a persistent and sizeable gender gap within computer specialisms and professions designing ICTs. The proportion of women entering computer science and engineering courses in most countries is static or in decline, in spite of sustained inclusion efforts. So, the overall picture across Europe is a contradictory one: optimistic with respect to what we call women *and* ICT (users), and pessimistic with respect to women *in* ICT (professionals).

BACKGROUND

The SIGIS project involved case studies of different types of inclusion strategies, backed up by a sizeable cross-cutting analysis (Faulkner, 2004; Rommes, van Slooten, van Oost, & Oudshoorn, 2004; Sørensen 2004). We investigated 30 different public and private sector initiatives which included women in the design or use of ICT (Lie & Sørensen, 2003; MacKeough & Preston, 2004); a further 18 "user studies" solicited end user experiences of selected strategies (Oudshoorn, Rommes, & van Slooten, 2003). These initiatives covered a range of everyday settings: school and university education in ICT, basic and vocational ICT training for socially excluded groups, support networks for professional women in ICT sectors, and the design of new ICT products for female markets. Some of the inclusion strategies were targeted at women while others were intended "for everybody," but all were successful to some degree. The SIGIS project therefore reveals that gender inclusion in the information society can occur through various strategies.

SOME GENERAL FEATURES OF DIGITAL INCLUSION

The so-called digital divide is typically seen as being produced through processes of exclusion, often related to entrenched social inequalities. Our starting point in the SIGIS project was that inclusion is not "just" a mirror image of exclusion. Stopping exclusion is not the same as achieving inclusion. So, inclusion activities should not "just" be directed at curbing exclusion mechanisms; they should also use explicitly positive measures. Too strong a focus on exclusion mechanisms may make inclusion seem impossible. Thus, our main interest has been on inclusion as a social process in its own right.

This said, there are several obvious areas in which mechanisms of digital exclusion need to be addressed through inclusion measures. First of these is *resources*. Statistical evidence on the digital divide reminds us that some people are digitally excluded because they are poor. The community-based ICT initiatives we studied confirm that resource barriers to digital inclusion can only be overcome through the provision of free access to and training in ICT, including free childcare where appropriate. Second, people must acquire *skills and knowledge* in using ICTs if they are to participate in the information society at any level. Less obviously, SIGIS cases reveal that informal learning (see below) is a vital feature of how people acquire ICT competence, even when they receive formal training. Third, *confidence building* and ICT skill building often go hand in hand; so confidence-building measures are key ingredients for success in ICT training. Fourth, diverse strategies confirm the importance of finding ICT applications or content *relevant to people's lives*. It is what the technology can do that makes ICT interesting to people—be it pursuing an existing hobby on the Internet, or communicating with distant family by e-mail. Many ICT trainers fail to appreciate this and teach ICT as "merely skills," rather than foregrounding the uses of ICT.

Making ICTs relevant can result in a process we have called *self-inclusion*. A dramatic example of this is the Lupus Web site, which provides information and advice to people (mostly women) who suffer from a rare auto-immune disease. Through its forums and chat rooms, these women developed a vibrant virtual community, providing mutual solidarity and support in learning about and living with this disease (Fortunati, 2004a). Similarly, all the Web magazines we studied succeeded in turning many women readers with no prior experience of the Internet into enthusiastic users, by addressing topics like health and fashion found in conventional women's magazines.

In sum, because digital exclusion is multi-dimensional, inclusion strategies (gender or otherwise) generally require a *heterogeneous* package of measures—heterogeneous in the sense of extending well beyond just making technology available. This simple but crucial message is still not fully grasped in some policy circles.

CHALLENGING GENDER BINARIES AND ESSENTIALISMS

Essentialist and binary understandings of femininity and masculinity (see definitions) are remarkably pervasive and tenacious. However, people's accounts of themselves are typically far more gender differentiated than their actual practices. For example, girl participants in a Norwegian computer party are seen (and see themselves) as "just users" or "chatterers," where the boys are described as "programmers" and "games players." Yet they are all skilful and enthusiastic users, and most do all of these things.

Across all of the inclusion strategies studied, the SIGIS team found a profound tension between embracing gender differentiated stereotypes and challenging them—not least because of the tendency for perceptions of gender difference to be exaggerated. On the one hand, drawing on gender essentialisms and binaries (although simplifying) can be effective in engaging otherwise excluded groups of women—as occurred with the Web magazines. On the other hand, strategies that draw on gender binaries and essentialisms risk exacerbating gender inequality, by ghettoising or stereotyping women. As we demonstrate later in relation to ICT product design, strategies that start from *plural* understandings of gender can be more inclusive.

Another effective strategy is to combine any appeal to gender stereotypes with efforts to move beyond or "destabilise" some of those stereotypes. This strategy was pursued by designers of the Web magazines, "Donna Moderna" in Italy and "Libelle" in the Netherlands (Fortunati, 2004b; MacKeough & Preston, 2004). They started from the "lowest common denominator" assumption that "women are computer reticent or incompetent and need user-friendly interfaces." At the same time, however, they made concerted and creative efforts to help their customers gain ICT skills—by creating interactive discussion sites and virtual communities for readers to learn through. These Web magazines are women-centred in the sense that they speak to "the modern woman," and so encourage self-inclusion by creating the motivation and opportunity for readers to become more familiar with using the Internet. They are also women-friendly in the sense that the readers learn about ICTs in part through interacting with—and getting advice, support and encouragement from—other women readers. Readers use these sites enthusiastically; in effect, they are experienced as a virtual "room of one's own." By facilitating such informal learning about ICTs, this strategy actively undermines, and so renders redundant over time, the original assumption of computer reticence or incompetence amongst women.

ONE SIZE DOES NOT FIT ALL

The SIGIS research indicate that the same inclusion measures may not be effective with different groups or in different settings; there can never be a single "cure all" strategy to improve gender inclusion in the information society—precisely because there is so much diversity and fluidity in both genders and ICTs. Multiple and diverse strategies are likely to be required for different technologies and uses, and for different social groups and settings. Context matters, and this means that *effective tailoring* is necessary if inclusion efforts are to succeed in reaching their target groups. Effective tailoring of digital inclusion strategies requires an awareness not only of how exclusion mechanisms may be gendered, but also of how inclusion mechanisms may be gendered.

This point is poignantly illustrated by the case of the "Ardmore Community Resource Centres"—a "for everybody" community-based ICT access and training network in rural Scotland, which failed to reach certain groups of middle-aged men (Faulkner & Kleif, 2005). Within this locality, more men are digitally excluded than are women of the same age, in part because they tend to be concentrated in outdoor manual jobs. To compound this, the strategy, which was so effective in drawing in even computer reticent women, did not work for these men. In a culture that remains strongly gender segregated, socially as well as at work, such community-based initiatives are marked as "women's spaces"—so not spaces where computer reticent men are likely to be willing to expose their ignorance.

The Ardmore case serves to remind us that gender in/exclusion is not just a "women's issue." It also demonstrates that good intentions about reaching "everybody" will not be effective unless they are backed up with a recognition of the *specific* ways in which diverse groups of women and men within the target constituency experience barriers to digital inclusion. Numerous SIGIS cases confirm the importance of bringing the technology to "where people are at." Effective tailoring of inclusion strategies thus means not only finding applications of ICT which interest people, but also finding mechanisms to effectively reach people in their existing social networks and practices. This latter point is key to the importance of informal learning.

INFORMAL LEARNING AND LOCAL EXPERTS

In all social settings and in all walks of life, informal learning about ICT is a vital part of digital inclusion (Stewart, 2001). It takes place alongside, and supplements, more formal kinds of learning. This was evident in the users of the Web-based magazines mentioned earlier, and in cases of occupational ICT training (civil servants and teachers). Informal learning is part of "domestication" processes, in which ICTs become "embedded" in everyday life. In this sense, informal learning is also *social learning*: interest and competence in ICTs evolve within complex interactions between education, work, and leisure. Yet, it is rare to find digital inclusion strategies that explicitly seek to facilitate informal learning.

Informal ICT learning involves what Stewart (2001) calls *local experts*—a friend, colleague, or family member who knows something about computers even if they have no formal expertise. SIGIS cases demonstrate that these local ICT experts play two really crucial roles. They act as positive role models—building confidence, competence, and enthusiasm about using computers. In addition, they are a free and accessible source of practical advice about computers and ICT, to whom we can turn if there is anything we do not understand or cannot do. People's life setting and social ties shape their particular networks of ICT experts. Most people under the age of 30 have learnt something about computers at school and are more likely to have peers who are competent computer users than do middle- and retirement-aged people. The latter more usually acquire ICT skills through work or from a local expert in the family.

The policy significance of these observations is enormous. Informal ICT learning through networks of local experts helping out and passing on their knowledge and enthusiasm to others is clearly crucial for ICT capability building over time. We need to understand better how people blend formal and informal learning, who they turn to as local ICT experts, and how these inclusion processes may be gendered in particular settings and groups. In addition, we need to devise mechanisms to nurture local ICT experts, and encourage networks of informal learning, so as to support the less computer literate or confident within digitally excluded groups.

WOMEN-CENTRED SPACES

We found that women-only community-based, vocational ICT training is extremely effective in meeting the needs of women whose self-esteem and confidence is low—as a result of being out of the labour market for some time, or being in other ways disadvantaged (Lie & Sørensen, 2003; Rommes, Faulkner, & van Slooten, 2005). This is a challenge to the many funding bodies that have ceased funding women-only technology training in recent years. It does not follow that the women-only route is either needed or effective for all women or for all types of training. However, the women-only model we studied does highlight the general value (for mixed or single ICT training) of several elements which together encourage confidence and ICT skill building: providing "safe spaces," one-to-one support, role models, networks of solidarity, and celebrating achievement.

Similar ingredients are found in networks for women who work within the ICT sectors and professions. These networks effectively empower women to overcome the "chilly culture for women" in ICT work (Pitt, 2004). They do this by enabling the women, who often feel rather isolated as women in ICT, to meet with others and to build skills and confidence related to career development.

In addition to these "bottom up" networks, there is a need for concerted "top down" inclusion efforts to tackle the "leaky pipe" problem whereby skilled and experienced women leave ICT professions and sectors disproportionately. This demands corporate attention to gender inclusion goals, flexible working conditions, work-life balance, and the like (MacKeough & Preston, 2003).

DESIGNING FOR WOMEN

Our case studies of the design of ICT products indicate that it is not always more effective to design for women specifically as opposed to designing "for everybody" *including women* (Oudshoorn, Rommes, & Stienstra, 2004). For at least two decades, the computer industry and ICT sector have been criticised for selling products and systems that are "made by men for men." This complaint has been particularly strong in relation to computer games, with many feminists arguing that the industry should develop games for girls and women in order to meet the needs of this potential market. The designers of two games we studied chose to do this. They started from stereotypical assumptions about differences between girls and boys, but discovered that girls did not want the "pink look" and "round shapes" they suggested (Oudshoorn, Rommes, & Stienstra, 2004).

Other game designers have realised that the differences between girls/women and boys/men with respect to computer game playing may be less than those *among* girls/women and *among* boys/men. More girls and women enjoy playing (existing) computer games than is usually assumed, even if they are critical of some "boyish" aspects. However, designers do recognise they need new designs in order to appeal to a wider cohort of girls and women. Accordingly, many of their strategies are about designing what we might call *trans*-gender games, which seek to cater for a variety of tasks and interests within the same game (Gansmo, Sørensen, & Nordli, 2004).

To the degree that design strategies targeted specifically at girls or women tend to assume all girls/women share the same interests and tastes, and do not move beyond gender stereotypes, their success will always be limited—and their impact will be gender conservative not progressive. By contrast, "for everybody" design strategies can work in attracting girls and women if, rather than treating the market as homogeneous, they acknowledge the *heterogeneous* interests and tastes amongst girls/women and amongst boys/men. Such trans-gender ICT products, based on plural understandings of gender, may ultimately prove more commercially successful. Once again, specifics matter: "women" is not a particularly useful design category, any more than is "men." Moreover, designing for gender heterogeneous markets raises interesting challenges in terms of design methodologies, especially where the designers are predominantly men (Rommes in this volume).

THE "IMAGE PROBLEM" AND THE STRENGTH OF NUMBERS

It has long been presumed that symbolic associations between technology and masculinity are important barriers to women's inclusion in ICT—in particular the (for women) "gender inauthentic", a-social connotations of the "nerdy" hacker image. One unexpected finding from SIGIS research is that this particular "image problem" may be very much less significant than expected.

It seems that any associations between masculinity and ICT are largely disappearing—or at least readily dismissed and easily overcome—with respect to "women *and* ICT" inclusion strategies. By contrast, strategies to encourage more women *in*to ICT frequently seek to change the image (if not the content) of computer science and engineering in order to make it more appealing to women. Often the emphasis is on how much ICT is fun and/or useful, for everybody—as in the fairly innovative strategies of "IT Beat" in the UK and the "Squares and Circles" campaign at the Norwegian University of Science and Technology (NTNU).

The latter strategy included a very high profile advertising campaign which played directly to the nerd/hacker image and associated gender stereotypes, arguing that computing needs more social skills which (it asserted) women bring. To our surprise, interviews with women who choose to enter computer science degrees during the period of this campaign revealed that this message was largely ignored. Although the wider initiative of which it was part did result in a significant increase in the number of women going into computer science, the main contribution of the advertising campaign was to convey the message that "women are welcome here." It seems that the most effective recruitment measures in the Squares and Circles campaign are those with a *direct* impact on the numbers of women entering computer science and engineering degrees—in particular, the introduction of quotas. We conclude that a *critical mass* of women needs to be reached—and be seen to be reached–before entry into ICT becomes a "gender authentic" option for girls and women (Lagesen, forthcoming).

A similar "critical mass" phenomenon is probably occurring with respect to the dwindling gender gap in ICT use. This suggests that one of the more effective ways to extend gender inclusion in the information society—in both design and use of ICTs—is to *make visible* the growing numbers of computer enthusiastic and competent girls and women. The more such counter-examples there are, the harder it is for people to view ICT as a technology for boys and men where the odd girl or woman is merely the "exception that proves the rule." Numbers matter!

FUTURE TRENDS

An important policy question with which we started our research was to explore how strategies to improve the position of women *and* ICT (i.e., women's use of ICTs) might impact positively on the number and position of women *in* ICT. It remains difficult to discern underlying trends and causalities clearly, but SIGIS research does point to some encouraging signs:

- The image which people have of computers is less a "techy," "for men only" image, as ICTs become an everyday part of social and economic life for more and more people.
- Designers are increasingly aware of the missing females in their markets, and increasingly reflexive about how they might attract girls and women to their products.
- Growing numbers of girls and women are doing things previously presumed to be the preserve

of boys and men—as computer enthusiasts, game players and, in some places, in computer science courses.

At the very least, it seems likely that there will be increasing crossovers between increasing use of ICTs by women and increasing numbers working in ICT—especially in a context where the boundary between using and creating ICTs is increasingly blurred in ICT work.

CONCLUSION

What is clear is that there is a serious lack of "joined up policy" in most countries with respect to gender inclusion in the Information Society, whereby government measures to bring women into ICT sit alongside wider digital inclusion efforts which are "gender blind". By contrast, the presence of state feminism in Norway means that public policies are frequently scrutinised to assess whether they help promote gender equality, and there is a strong awareness of gender as a potential dimension in the digital divide. The lack of explicit and comprehensive treatment of gender inequality around ICT within most European countries is worrying given the clear indications that gender gaps in digital inclusion will not disappear without intervention. Gender blindness in digital inclusion strategies may even exacerbate the exclusion of specific groups (of men as well as women). If governments are serious about gender inclusion in the information society, then a thorough gender awareness must permeate all digital inclusion strategies–be they education, work or community based–and policies are needed to link digital inclusion efforts (around ICT use) to efforts to recruit more women into ICT.

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KEY TERMS

Digital Exclusion: Involuntary lack of access to or skills in ICTs.

Digital Inclusion: Access to and skills sufficient for using ICTs for seeking information and communicating.

Gender and ICT: Whether people of both genders are *users* of the various ICTs.

Gender Binaries: Male/masculine and female/feminine are defined in opposition to each other.

Gender Essentialism: Gender differences are perceived as given by nature and unchangeable.

Gender in ICT: Whether both genders work in the ICT professions *developing* ICTs.

Information Society: A society where ICTs are a necessary means for communication, for public as well as private ends, and where those who are unfamiliar with ICTs are marginalized.

Trans-Gender: Appealing to *plural* genders (but not gender neutral).

ENDNOTE

1 The project, Strategies of Inclusion: Gender and the Information Society, was conducted between 2002 and 2004. The partners in the project were Dublin City University (Ireland), Studio Metis (Italy), The University of Twente (the Netherlands), the Norwegian University of Science and Technology (Norway) and The University of Edinburgh (UK) which coordinated the project. The research was supported by the European Commission, 5th Framework, Information Society Technologies (IST) Programme (IST-2000-26329). All of the research reports, plus practitioner and policy guidelines, are available on the SIGIS Web site (www.sigis-ist.org).

Gender Inequalities for Use and Access of ICTs in Developing Countries

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INTRODUCTION

Internet, wireless, mobile, multi-media (voice, video, 3D), broadband, and other information and communication technologies (ICTs) are rapidly consolidating global communication networks and international trade with implications for people in developing countries. Extensive literature suggests that use of ICTs have a great impact on society for improving their economic means and life styles. However, various studies conducted in different regions of the world indicate that the advantages of ICTs have not reached all sections of society, particularly rural communities, and women. Women face many obstacles before they can harness the benefits of ICTs (Accascina, 2001; Alloo, 1998; The Commonwealth of Learning, 1998, 1999, 2000, 2001).

Information and technology development, adoption, and access are far from adequate in developing countries. Large scale illiteracy and disabling environments, including uncompetitive markets, restrict opportunities to harness ICTs. For example; in India only 0.6% of the population uses the Internet and the penetration rate of the personal computer is only 1.2% (Hafkin & Taggart, 2001; Nath, 2001; World Bank Report, 2002). Information chasms follow socioeconomic divisions, particularly income and education disparities, separating well-connected elites from the less privileged who remain detached from information access and use. Most women within developing countries are on the lowest side of the divide, further removed from the information age as compared to the men whose poverty they share (Accascina, 2001; Nath, 2001; Tandon, 1998, The Commonwealth of Learning, 1998, 1999, 2000, 2001). If access and use of these technologies is directly linked to social and economic development, then it is imperative that women in developing countries be taken into consideration while developing ICT diffusion strategies. ICTs can be an important tool in meeting women's basic needs and can provide the access to resources to involve women as equal partners in socio-economic development (Cole et al., 1994). Addressing gender issues in the ICTs sector has shown significant results where women have been made a part of ICT use and access. For example, women have benefited greatly from South Korea's push to make higher education available online. In corporate South Korea, more than 35% of high-level IT positions are now held by women. In Africa, 70% of agricultural produce is handled by women (World Bank Report, 2002). By using farm radios, women farmers can obtain information in local languages on markets, agricultural inputs, food preservation, and storage without traveling far, or being dependent on a middleman. ICTs use and access by women can offer significant opportunities for them in developing countries, including poor women living in rural areas. However, their ability to take advantage of these opportunities is contingent upon conducive policies, an enabling environment to extend communications infrastructure to where women live, and increasing educational levels. It is now, particularly appropriate to ensure the inclusion of gender concerns in national IT policy, as most developing countries are either in the process of or about to start elaborating these policies (Accascina, 2001; Marcelle, 2000; Ponniah & Reardon, 1999; The Commonwealth of Learning, 1998, 1999, 2000, 2001).

Women face considerably higher barriers in terms of literacy, access to education and information, productive and financial resources, and time. Many of the obstacles women face in accessing and using technology are entrenched in behavioral, cultural, and religious practices. Unless explicit measures are taken to address these divides, there is a risk that ICT will increase gender disparities and that the impact of ICTs will not be maximized. Integrating gender considerations into ICT strategies and policies will enable policy-makers and implementers to address these differences, which in turn will lead to remove gender inequalities for ICTs use and access (The Commonwealth of Learning, 1998, 1999, 2000, 2001).

BACKGROUND

ICTs bring the promise of new and better jobs and businesses for women, fuller participation in the political process, communication with worlds outside the boundaries of home and community, easy access to information and resources that can change lives, and the ability to acquire education and skills and to transcend social restrictions. These all can empower and enhance the quality of women's lives in developing countries. The Internet and other ICTs are proving to be a powerful tool to empower women to inform and change global and local realities. The opportunities and the benefits as well as the challenges of new information and communication technologies, as a tool of communication and knowledge transfer to support development and advancement of women in social and economic arenas are proving critical to women's networking and political action around the world. Considering odds against women taking part in the information super highway, women's groups and even poor communities are making full use of the Internet to defend and advocate for their rights. A key strategy for women's empowerment, especially in marginal and poor communities, is to give women access to new information technology in appropriate ways that support women's everyday work and help them fight for and defend their human, social, economic and political rights (Green & Trevor, 2002).

Even as the power and potential of these technologies are recognized and celebrated in most policy circles, the fact remains that unless the poor and marginalized are actively involved they will remain marginalized. Hence, there is a need for actions that are explicitly aimed at introducing the poor/marginalized, of which women are the majority, to these technologies. The gender gap in the digital divide is of increasing concern; if access to and use of these technologies is directly linked to social and economic development, then it is imperative to ensure that women in developing countries understand the significance of these technologies and use them. If not, lack of access to information and communication technologies becomes a significant factor in the further marginalization of women from the economic, social, and political mainstream of their countries and the world. Unless women are provided effective access to ICTs, they will be left behind in their participation in the global world of the twenty-first century.

BARRIERS FOR WOMEN OF ICT USE AND ACCESS

Most women in developing countries who use information technology use it at work. Except in upper-income enclaves, home access to a computer and the Internet is not a common. E-mail is the major ICT application that women in developing countries use. Also, since women are given roles to manage the home and kids and their school tasks, women find very little time to use ICTs for any recreational or communication purposes (Ranchod, 2000). Broadly speaking, the barriers to women's use of ICTs have been:

- General literacy and language
- Lack of technical training
- Lack of access to hardware, software or access to the technologies
- Cost of connections still high for the lower income women
- General "technophobia" among women
- Social and cultural barriers—women are still the primary care-takers for their children and carry the bulk of household responsibilities, therefore have less time to explore the uses of new ICTs
- Full Internet access is limited in the academic sector and in corporations to those who hold managerial and/or technical posts, and the number of women in these positions is relatively small compared to men

Many of these barriers arise directly from the status of national illiteracy levels and national connectivity information infrastructure. However, systemic problems of general illiteracy combined with infrastructural barriers work against women. Some of these barriers are described in detail in the next section.

Cultural Barriers

Cultural and social attitudes often discriminate against women's participation in the fields of science and technology and limit their opportunities in the area of ICT. In several countries, the most binding constraint to the diffusion of ICT is often not technology *per se*, but the culture surrounding the use of information in general. In some countries, the benefits of an open information culture, including direct exchanges among citizens, between citizens and government and internationally, has not percolated yet to a critical mass capable of creating substantial upstream changes. De-learning old habits is probably needed before embracing new ICT. Most women will not perceive the benefits of ICTs, nor will they be able to use them to their full potential, unless they can see an immediate benefit or result of participation in ICTs.

Language

Language usage also plays an important role. Although some regional information mechanisms have been created and are being maintained today, the languages used are primarily English. This exacerbates the hub-and-spoke effect. A number of initiatives are taking place to facilitate the use of ICT in local languages but so far, numbers are far behind. Lack of standardization, limits the use of the local language. English is the established language of the Internet. English is used among the more educated members of the society in India. Non-English speaking women find it hard to use ICTs due to language barriers.

Financial and Budgetary Constraints

Women are often financially dependent upon men or do not have control over household expenditures. This makes accessing ICT services more difficult. In some countries, women's seclusion from the public arena makes accessing community Internet centers difficult. The prohibitive costs are a major constraint. The costs involve the purchase of the necessary equipment, obtaining and maintaining connectivity, and usage charges.

While many women may be interested in using and accessing the Internet, the cost limit constrains them. Aside from budgetary constraints, women cited internal constraints such as culture, and attitudes.

Telecommunication Infrastructure

The majority of women who have access today for ICTs are from research institutions, governments, and some businesses. Access among poorer and rural classes is currently non-existent, but critical for women's development. The benefits from ICTs and the adverse effects that might ensue from not accessing them cannot be embraced without adequate telecommunication infrastructure. Underdeveloped telecommunication infrastructure remains an important impediment to the expansion of ICT use in most countries. While computer prices have declined closer to international standards, telecommunications continue to be both costly and of limited availability. In India, all electronic media, ranging from satellite television to e-mail and the Internet, are accessible only to the privileged classes and cater almost exclusively to their predominantly male culture.

Illiteracy

Given the low levels of literacy (reading and writing), let alone computer literacy in many developing countries, the opportunities presented by new digital information systems are a long way from reaching the hands and eyes of the majority. ICT is not the answer in itself to poverty and social exclusion—design of applications, accessibility of 'access points', and the design and delivery of training in ways adapted to women's needs, concerns and purposes for usage will determine whether and how they are used by women. Approaches to training women to use ICTs need to be appropriate to their interests and usage. Women also have awareness barriers for use and access of ICTs. There are three types of awareness issues that act as obstacles to women's use of communication technologies: awareness of personal ability, awareness of the utility of communication technologies, and awareness of available resources.

Education and Training Skills Barriers

A fundamental barrier to women's use of ICTs in developing countries is illiteracy. The danger in such a situation is that ICTs will widen and deepen the gap between the haves and have-nots as economies become more and more information-based. Inequitable allocation of education and training resources often favors boys and men. Education and training opportunities are not available in developing countries to educate women in use and access of ICTs. Women are marginalized in accessing education and training due to cost and access factors resulting in tremendously uneven IT skills between men and women. Most of the women's IT skills are self-learned. Although there may be ICTs training facilities, few women take advantage of these courses due to a variety of reasons: high fees, a feeling of intimidation in joining male-dominated courses that are moreover often taught by male trainers, and the ever present demands of family responsibilities.

Measures be Taken by Policy Makers

In order to ensure women's ability to take advantage of opportunities presented by ICTs, gender and development policy makers need to be sensitized to ICT issues. Proactive policies and programs that meet the needs of women for use and access of ICTs. Matching the most appropriate communications technology with people's needs and capabilities is a crucial task for ICT providers. Steps must be taken to address the needs of languages and cultures through longer-term vision to make all ICTs accessible to women. This will involve significant investment and support for local content (in broadcasting and the Internet) and software design.

Increasing women's access to information and communication technologies in developing countries involves increasing availability of communication in areas where women live, most women in developing countries live in presently underserved areas. Extension of infrastructure, particularly wireless and satellite communications, to rural areas and semi-urban areas is crucial to increasing women's access to information technology. Emphasis needs to be on common use facilities, such as tele-centers, phone shops, and other forms of public access in places convenient and accessible to women. The policy makers should devise policies to improve the ability of girls and women using ICTs in developing countries. Such improvement requires interventions at all levels of education. A key strategy for women's empowerment, especially in marginal and poor communities, is to give women access to new information technology in appropriate ways that support women's everyday work and help them fight for and defend their human, social, economic and political rights. The use and access of ICTs offer many new opportunities for women in developing countries a lifeline for economic, social, and political empowerment. ICTs can be empowering for individual women and for women taking collective action. This requires core funding for women's organizations as well as investment in equipping them with ICT resources (Unpublished manuscript, 2002).

Costs are a significant barrier to usage and training for poor women, for whom household needs will always be a first priority. All costs associated with access and training must therefore be met: transport, appropriate childcare, and/or disability or elder care, and making appropriate practical arrangements to accommodate other needs. If proper diffusion strategies are adopted for ICTs, with women in focus, they can certainly meet women's basic needs and access to resources. Removing barriers to women's ICT access offers potential to connect low income women to the democratic process, improve their access to services and resources, and strengthen their roles as community net workers (Accascina, 2001; Marcelle, 2000; The Commonwealth of Learning, 1998, 1999, 2000, 2001).

Since cost, technology expertise, repair and infrastructure issues will ensure that ICTs stay out of the reach of most individuals for the foreseeable future, alternative systems of access, delivery and information will need to be developed that are more appropriate to the situation of women. This is especially true for women, who tend to have less economic power, training, and technical expertise.

FUTURE TRENDS

Growing numbers of girls and women are doing things previously presumed to be the preserve of boys and men—computer enthusiasts, game players and, in some places, computer science courses. The

ICT sector in many countries, including developing countries, is contributing to increased employment and economic opportunities for women. For instance, in the Kerala Technopark in India, women form nearly 40% of the computing work force. ICT allows access to a global market for even a small business with minimum initial investment. ICT, therefore, provides a unique opportunity to promote the growth of women-run small businesses. Women compose a significant share of micro, small, and medium entrepreneurs in developing countries. In order for them to participate in the new knowledge-based economy, appropriate training and support to use ICTs are needed. The policy makers need to include women in policy dialogue and provide them women-friendly ICT access infrastructure. They should be provided training and testing in a structured, culturally-acceptable environment. More number of success stories of women using ICTs need to be prepared where they can be depicted as role models for young girls. Role of ICT in building positive role models is very crucial. Especially in the context of the Middle Eastern region where access to ICT has a strong male bias and Internet cafes are not women-friendly. Apart from government agencies, many other NGOs organizations need to work together to reach to women of different socio-cultural and economic considerations to attract women for participating in ICT projects. Access to loans, credit, and capital remains a barrier in ICT-based entrepreneurial activities among women.

In order to facilitate access for women from all classes and sectors, ICTs will need to be located in local institutions to which women have open and equal access, such as health centers, women's NGOs, women's employment centers, libraries, women's studies departments and institutes, and perhaps even churches. The location in these types of contexts also pertains to the practical, specific kind of information that women require as a result of their time constraints.

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KEY TERMS

Digital Divide: The digital divide is the disparity in access to technology that exists across certain demographic groups. A term used to describe the discrepancy between people who have access to and the resources to use new information and communication tools, such as the Internet, and people who do not have the resources and access to the technology. The term also describes the discrepancy between those who have the skills, knowledge, and abilities to use the technologies and those who do not.

ICTs: ICTs include telecommunications technologies, such as telephone, cable, satellite, and radio, as well as digital technologies, such as computers, information networks, Internet and software.

Information Infrastructure: Information infrastructure refers to all telecommunications and computer networks world-wide to store, process, and disseminate information. The Internet is considered the de facto global information infrastructure right now.

Internet: The Internet is a worldwide communications network originally developed by the U.S. Department of Defense as a distributed system with no single point of failure. It is a system of interconnected networks that electronically links computers from around the world via the TCP/IP protocol.

Literacy: There are no universal definitions and standards of literacy. Unless otherwise specified, all rates are based on the most common definition—the ability to read and write at a specified age.

Gender Influences on Ethical Considerations in the IT Environment

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INTRODUCTION

We become just by performing just actions.
—Aristotle, Nichomachean Ethics, 4th century, B.C. (Miner & Rawson, 2000)

From the opening statement, it is evident that ethics has played a part in our everyday lives since the beginning of time, and still continues to do so. Another aspect of our lives that has become increasingly widespread is the use of information technology. In the Information Age, it is not often that we link ethics and information technology (IT).

This article examines the link between ethics and IT, and the influence of gender on ethical considerations in the IT environment.

BACKGROUND

Definitions

Ethics have been defined as, "The behavioural manners and norms of a group or society" (Takala & Urpilainen, 1999). Are males and females classified as one group? Or do their ethical considerations differ?

Multi-Dimensional Scale

A multi-dimensional ethics scale (Reidenbach & Robin, 1990) was used, as opposed to a single-item scale. A single-item measurement scale is inadequate for complex phenomena such as ethics. Ethical decision-making is not always affected by a single factor. In some situations, individuals might consider only one dimension, whereas in other situations, they consider a few dimensions (Grupe et al., 2002). It should be noted however, that this multi-dimensional ethics scale can only assess community standards, and is not able to assess right versus wrong.

PREVIOUS STUDIES

Previous studies have been conducted on ethical attitudes. In a study examining whether a group of MBA students, when asked if they would attempt an illegal act that would net them or their company a profit of more than $100,000 if given a 1% chance of being caught, more than one-third responded "yes". (Liberman & Etzioni, 2003).

Previous studies have also been conducted on gender influences on ethical attitudes. Christie et al. (2003) investigated the influence of personal characteristics of business managers from India, Korea, and United States. Characteristics included age, gender, personal beliefs and the values of on one's ethical perceptions, attitudes and conduct. It was found that there was a significant difference in ethical attitudes of business managers due to gender.

Ross and Robertson (2003) also found gender to be statistically significant in effecting the ethical attitudes of professionals. It was noted that some studies on gender differences found females more ethical than males (Arlow, 1991), while other studies found males to be more ethical than females (Fritzsche & Becker, 1983).

Upon review of research conducted on ethical conduct, one study noted that almost half (49%) of respondents said that ethical conduct is *not* rewarded in business today (Anonymous, 2003). However, in the same study, 79% of the respondents said their organizations have written ethics standards, and believed that top management supports those ethics (Anonymous, 2003).

These statistics indicate that the adoption of ethical behaviour is viewed favourably, but yet findings reveal that many do not believe that ethical conducts reaps benefits in the long run.

Further study on ethics is important as there are many benefits in acting ethically such as retaining employees. Studies have found that employees are more likely to remain loyal to organizations who they believe are ethical (Smith, 2000). Ultimately, good employees add to the bottom line. Studies have also found that there are associated cash costs to unethical behaviour, for example, internal fraud (Morse, 2003). Other intangible benefits of ethical behaviour are increases in trust levels (Keefe, 2002), and good reputation (Sheffert, 2001).

A greater understanding of ethics will provide an insight into how ethical behaviour relates to various factors such as educational background and income levels. This study looks at how ethical attitudes are affected by gender differences. This research contributes to the existing body of knowledge by examining differences in ethical attitudes, employing quantitative statistical methods. This enables the significance of differences due to gender to be quantified. Such analyses is lacking in literature today. The quantitative method employed is further detailed in the Data Analysis section below.

RESEARCH OBJECTIVES AND RESEARCH QUESTIONS

As we can see from previous studies, varying results were found when gender was examined as a factor for ethical considerations. What role does gender then play in the ethics of the IT environment? This study seeks to understand the differences in attitudes of IT practitioners due to gender, to see if they are consistent with previous findings on other populations.

The objective of this research is to understand IT practitioner attitudes to ethics. Therefore, the research question that drives this study is, "Is there a difference in attitudes of IT practitioners to ethics due to their *gender?*"

The next section addresses the methodology used for the evaluation of the data.

METHODOLOGY

Data Collection Method

This study uses a quantitative approach for evaluating data collected. Surveys were used as the data collection method. An online electronic questionnaire was selected as the survey instrument.

The hypothesis for this study is:

$H_0$1: There is a difference in attitudes of IT practitioners to ethics due to *gender*.

The dependent variables are the *scale items* (fair, just, acceptable, etc). The independent variable is *gender*.

Items on Multi-Dimensional Scale

Questionnaires were used together with an accompanying scenario written as a series of four vignettes. Online electronic questionnaires, housed by an online questionnaire-hosting site, Informis (2005) were used. A link to the survey was presented on the Project Management Institute (PMI)'s Web site. As the site is visited by project management practitioners worldwide, a wide variety of respondents were captured from all parts of the world, at no additional cost. The drawback to this is that the exact response rate cannot be determined, as there is no way of ascertaining the number of readers that responded to the survey.

A link to the survey was also included in Harrison International Limited's Web site[1]. Harrison International Limited is an international consulting company, providing consulting services in project management and strategic management to organizations around the world. This was deemed a highly appropriate way of recruiting respondents for the study, as respondents would be business professionals, closely related to the target respondents for this study.

The survey and associated scenarios were developed from earlier studies carried out by Reidenbach and Robin (1990) and Tuttle et al. (1997). The associated scenarios were written for business circumstances and based on scenarios that could be present in software development projects.

Table 1.

Duties of cared owed: (ACM, 1992; IEEE, 1990; NZCS, 2003)	**Replace *Family* item in the multidimensional scale with**:
• Society • Clients • Colleagues • Profession • Professional affiliation	• *Acceptable to colleagues* • *Acceptable to clients* • *Acceptable to society*

The questions in the questionnaire were adapted to encompass other factors that influence ethical considerations. The Codes of Ethics of IT Professional Bodies stress that ethical decisions should be made with reference to the duties of care to: colleagues, clients, society, employer, profession, and professional affiliation (ACM, 1992; IEEE, 1990; NZCS, 2003). Hence, the statement pertaining to family in Reidenbach and Robin (1990)'s scale is replaced by duties owed to colleagues, clients and the society. This is displayed graphically in Table 1.

Thus the scale looks like this:

- **Dimension One:** A broad-based moral equity dimension
  - Fair/Unfair
  - Just/Unjust
  - Acceptable/Unacceptable
  - *Acceptable/Unacceptable to colleagues*
  - *Acceptable/Unacceptable to clients*
  - *Acceptable/Unacceptable to society*
  - Morally/Not morally right
- **Dimension Two:** A relativistic dimension
  - Traditionally Acceptable/Unacceptable
  - Culturally Acceptable/Unacceptable
- **Dimension Three:** A contractualism dimension
  - Does not violate/Violates an unspoken promise
  - Does not violate/Violates an unwritten contract

Added variables

The Four Scenarios

Four scenarios were developed specifically for this research study. The four scenarios used are:

- Project Initiation
- Project Development
- Project Staffing
- Project Termination

Each case vignette details a scenario commonly encountered in the IT environment. The vignettes follow the software development life cycle closely, such that there is a project beginning (e.g., Initiation), middle (e.g., Development and Staffing) and end (e.g., Termination). Respondents are asked to rate the action taken in the scenario from different viewpoints (e.g., fair/unfair, acceptable/unacceptable to clients, acceptable/unacceptable to society, etc.). They rate the action taken on a scale of 1 to 10, with 1 being most fair, and 10 being most unfair.

Project Initiation

The first case vignette, Project Initiation, is about presenting complete information when tendering for a project. It describes that there is ambiguity in the specifications provided by the client for a software development project. However, the software development team needs the job, so they need to consider if they are to reveal potential cost overruns to the client, or to tender at a lower than realistic cost, knowing that they will be able to charge more later. The respondents are then told that the software development team under quotes on the price of the contract, in hope of getting the contract, and making up for any shortfalls by variation orders later in the contract.

Project Development

The second case vignette, Project Development, is about professional honesty and communication of issues. It describes a situation where the software development company tendered and obtained the job at a low cost. However, the job turned out to be more complex than expected. The client has agreed that the original specifications they provided were imprecise and omitted needed functionality. The project was then re-evaluated and an additional set of requirements agreed to and priced. The respondents are then told that the software developer continues to work on the project despite knowing that there will be cost overruns and the project will most likely fail.

Project Staffing

The third case vignette, Project Staffing, is about being to right socio-economical imbalances. It describes how the project manager had to advertise for additional staff for the project. There had recently been an equal employment opportunities (EEO) directive to employ more females. Very few females applied for the job. Of those who did, none were strong candidates for the position, but the Human Resources department is insisting that they be employed and be given on the job training to rectify any perceived shortcomings in their qualifications and skills. If they are employed, it could jeopardise the project budget even further. Respondents are then told that the project manager employed a female, even though she was not best qualified for the job.

Project Termination

The fourth and last case vignette, Project Termination, is about the integrity of lower-level team members who are under direction of managers. It describes how the project was eventually completed. It cost five times the original price and took twice as long. The client representative has told the software developer that he knew all along that the original set of requirements and specifications were inadequate, but he wanted them to get the job, so he encouraged the project to go ahead. He now wants a $15,000 sweetener for this project, bearing in mind that there are other projects in the pipeline for the now expanded team. The software developer approached his project manager about this and the project manager has told him to work it into the budget somehow, and that in fact, he went to school with the client who gave them the opportunity to quote for the job as a much-needed favour. Respondents are then told that the client representative was paid the sweetener, and asked to rate the action taken in the scenario.

Data from the questionnaires were then collated and analyzed for patterns. This study analyzes the gender effect on respondent attitudes to ethics. While attitudes to ethics may be affected by other influential effects such as income, work experience, and educational background, the separation of the gender effect from other influential effects is outside the scope of this study. For further details, refer to Leong (2003).

DATA ANALYSIS

Two hundred usable responses were received for the survey. The demographic distribution of the sample is detailed in the Table 2.

Before embarking on detailed analysis, a check was made to see that there does appear to be some pattern in the questionnaire responses. With this in mind, the response patterns for each of the 11 items used in the four scenarios were visually inspected. This will indicate if all items act in the same way and if each of the four scenarios meets with a similar response. Data was also checked for normality to confirm that the data collected was of normal distribution.

Having tested if there is indeed a pattern in the responses and that it does depend on the attitudes to the various dimensions of ethical behaviour, the

Table 2. Demographic distribution of sample

	Sample Respondent Groups	Sample
Gender	Male	64.7%
	Female	35.3%
Age	Under 20	2.0%
	20-29	50.0%
	30-39	22.0%
	40-49	14.7%
	50+	11.3%
Highest Education Level	Primary School	0.0%
	High School	10.7%
	Undergraduate Student	54.4%
	Postgraduate Student	34.9%
Ethnicity	European	56.0%
	Chinese	27.3%
	Indian	6.0%
	Other	10.7%
Household Annual Income	Less than $36,000	12.7%
	$36,001-$50,000	27.1%
	$50,001-$70,000	22.9%
	$70,001-$90,000	10.2%
	Over $90,000	27.1%

hypothesis was tested. The hypothesis was tested using analyses of variance (ANOVA), as to whether gender might account for individual differences in attitudes to project management ethics.

RESULTS

The sum of scores received for the four case vignettes were calculated. A comparison of scores was performed for male and female respondents for the four case vignettes.

It was found that there were no significant differences in mean scores due to gender in all four scenarios. Although not statistically significant, in the Project Initiation and Project Development scenarios, the female scores were higher, whereas in the Project Staffing and Project Termination scenarios, the male scores were higher. This indicates a higher concern for ethical considerations in females in the Project Initiation and Project Development scenarios, and a higher concern for ethical consideration in males in the Project Staffing and Project Termination scenarios. Scoring higher meant that the respondents viewed the scenario as being more unethical than those who scored lower.

DISCUSSION OF RESULTS

Results from the analyses shows that while there is no difference between the scoring patterns of male and female respondents, the scoring pattern depended on the scenario.

It is not surprising that males would express more concern in the Project Staffing and Project Termination scenarios, as it could be interpreted that females are to be preferentially selected in the Project Staffing scenario as a form of positive discrimination.

Findings for the Project Initiation and Project Development scenarios were also consistent with Arlow (1991), where females were found to be more ethical than males. However, findings for the Project Staffing and Project Termination scenarios were consistent with Fritzsche and Becker (1983), where males were found to be more ethical than females.

It was noted that while female scores were higher in the first two scenarios, when scores in the four scenarios were compared against the two genders, there were no significant differences found. This suggests that gender affects ethical considerations in the environment presented, depending on the nature of the situation encountered.

CONCLUSION

Limitations

There is a limitation to studies on ethics in general. Ethics has been said to be the connection between morals and the telling of truth. According to Bok (1981), the "whole truth" is unattainable to a human being Takala and Urpilainen (1999). Therefore, it is difficult to place a right or wrong answer on any studies conducted on ethics. An evaluation of real-life situations may be at variance with hypothetical scenarios.

Value of this Study

This research study has come up with some findings that would be of interest not only to practitioners, but researchers alike. This study has provided further insight to the effect gender has on our ethical considerations, by not just presenting a set of conceptual theories, but quantifying the significance of difference in ethical attitudes using the quantitative methods detailed above. The subject of ethics is quite hard to define and much empirical analysis could be conducted to gain a better understanding of this subject area.

FUTURE TRENDS

There has been a sharp increase in interest on gender differences in IT. From recent statistics, it has been advocated that there is a shortage of females in the IT discipline. Further research on gender differences in IT may shed some light on the key factors contributing to this situation. Future studies may want to examine if male practitioners in IT believe that there is a gender imbalance. Further research could be done on male IT practitioners' behaviour toward females in the industry, and to examine if males have a positive or negative perception toward their female counterparts. Results from these studies will enhance our understanding on this subject area.

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KEY TERMS

Dependent Variable: The observed variable in an experiment or study whose changes are determined by the presence or degree of one or more independent variables.

Ethical Consideration: What would or would not be ethical behaviour under specified circumstances.

Gender: The condition of being female or male.

Independent Variable: A manipulated variable in an experiment or study whose presence or degree determines the change in the dependent variable.

Information Age: The period beginning in the last quarter of the 20^{th} century and noted for the abundant publication, consumption, and manipulation of information, especially by computers and computer networks.

IT: Abbreviation for information technology.

Practitioner: One who practices something, especially an occupation, profession, or technique.

Systems Development Life Cycle: Any logical process used by a systems analyst to develop an information system including requirements, validation, training, and user ownership.

Vignettes: To describe in a brief way.

ENDNOTE

1 http://www.harrison.co.nz/HTML/Overview/LinksExternalEvents.htm

Gender Issues in Eastern Europe

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INTRODUCTION

This article aims to indicate a working agenda of Eastern European gender issues and to generate critical reflection and further research questions.

Although many alternative definitions exist, Eastern Europe is identified here as the totality of postcommunist countries (from ex-East Germany to the ex-USSR [Union of Soviet Socialist Republics] countries, including Russia) that are now undergoing a process of transition to democracy and a market economy (see map). Despite past similarities caused by the sharing of the same type of political oppression, these countries differ somewhat in their treatment of gender, partly due to their precommunist past, partly due to their particular socioeconomic and historical circumstances. Thus, any generalizations drawn here must be taken with a grain of salt, and one must remember that neither the category of women nor the concept of Eastern Europe, or postcommunism for that matter, is monolithic.

BACKGROUND

One of the difficulties confronting gender analyses for this area is that Eastern European societies are not used to nor equipped with the tools that would allow them to analyze their issues in terms of gender (Frink, 2001). Indeed, in some languages the term gender either does not exist or implies an often radical redefinition of existing terms (Funk & Mueller, 1993). In many cases, Eastern European feminists need to learn or create a vocabulary and a space to talk about women's issues, often having to face opposition, ridicule, and marginalization from a profoundly patriarchal society. One of the reasons for this is that totalitarian regimes were solely concerned with class struggle above all other societal inequities. While women's issues were discussed under communism, some authors (Miroiu, 2004) claim that one cannot speak of communist feminism as an ideology on account that communism promotes neither individual rights nor personal autonomy. This argument seems to be supported by many Eastern European feminist researchers, who see a basic incompatibility between feminism and the communist denial of subjectivity and individualism, its universalism, and its collectivism (Funk & Mueller, 1993). Since access to information under communism was severely restricted, the issues on the agenda of Western feminism did not truly appear on the Eastern European intellectual market until after 1989, and even then they appeared as a trickle.

One striking commonality of basically all the former communist states in Eastern Europe is that they regarded equality between sexes as a fait

Figure 1. Map of Eastern Europe (Source: http://www.lib.utexas.edu/)

accompli (see Funk & Mueller, 1993; Gal & Kligman, 2000a), as communism had postulated it. Since this supposed equality had never been questioned under communism, and since other more stringent issues deemed urgent attention at the time (marketization, economic stability, political transition, sweeping institutional reforms, etc.), the emergence of a serious dialogue about women's issues was often slow and met with opposition from women themselves. East European women scholars appropriated, rejected, or made Western feminism problematic in a dialogue that has known both successes and failures (Funk & Mueller, 1993; Renne, 1997). Newly arisen feminist issues also had to face a deeply ingrained antifeminist ideology, which survived communism, perestroika, and transition as well.

After the fall of the Iron Curtain, much of the enthusiasm and hope with which the new free nations met a democratic era gave way to the harsh realities of the transition to a market system: job insecurity, unemployment, inflation, poverty, unpopular reforms, social unrest, and in some areas, violent ethnic war. Although the changes were felt by society as a whole, women were particularly affected, and researchers generally agree that the anticommunist revolution led to losses for women in terms of civil, economic, and political rights, and even provided "another breeding ground for substantial discrimination against women" (Wejnert, Spencer, & Drakulic, 1996, p. xiv).

CRITICAL WOMEN'S ISSUES IN EASTERN EUROPE

Reproductive Policies

These were some of the first issues raised by the newly free states, as Gal and Kligman (2000a, 2000b) point out. The lingering presence in public and political debates of abortion, contraception, sterilization, and policies related to sexuality and family (from rape to day care) indicates the importance of reproductive policies, despite their not entering the realm of public consciousness as gender issues but as political and ideological problems. Although they are similar in that they treat reproduction as a very important political issue, Eastern European states vary widely in their reproductive policies. In Poland, the renewed influence of the Polish Catholic Church led to severe restrictions on abortion and to debates that still continue in parliament; a similar situation exists in Hungary. Romania is an extreme case: After years of very restrictive antiabortion regulations determined by Ceausescu's pronatal policies, the second official decree after the dictator's fall in December 1989 was lifting the ban on abortion. In Romania, like in Stalinist Russia, women with more children were conferred the title of heroine mothers, and childless families had to pay higher taxes. Ethnonationalism played a role in natality policies also in Hungary and ex-Yugoslavia: Making the members of a nation (of a certain ethnicity) was the women's duty and ensured the propagation and prosperity of that nation. That is why, for example, rape was used as a weapon of war in the former Yugoslavia: Apart from attacking the women, in the cases where it resulted in children, it ensured the ostracizing of those mothers and children by their own culture while perpetuating the aggressor's ethnicity (Nikolic-Ristanovic, 2002). To date, abortion rights are restricted and even threatened in many Eastern European countries (with the exception of Romania).

Family Roles and Employment

Most communist states are similar in that women were present on a large scale in the paid workforce (largely because at least two salaries were required to sustain a family), but they held overwhelmingly feminized jobs (secretarial, health, education, textiles) and low-paid, low-authority positions. Also, extended maternity leaves both enabled women to work and cemented their traditional role in the household, while also serving to "legitimize gender inequality and discrimination in employment" (Funk & Mueller, 1993, p. 7). The drastic changes during the transition (e.g., higher unemployment, lack of funds for day care, etc.) led in many cases to women's ambivalent positions toward work and family. Wejnert et al. (1996) remark that women were the first to lose their jobs during the postcommunist downsizing. In many countries, these factors led to cultural expectations of women as being primarily mothers and housewives. One strong trend among women in certain Eastern European countries was to stay home, which was then seen as the true face of liberation. This is just one trend that led to the opinion of many authors (Gal & Kligman, 2000a; Matland & Montgomery, 2003; Nikolic-Ristanovic, 2002) that the end of the communist regime hailed a return to a natural precommunist state, including a traditional hierarchy between the sexes. This retraditionalization or renaturalization of gender roles seemed desirable partly because it went against communist tenets.

Attitudes toward technology play an important role in shaping sex roles and women's employment. Much like women in the rest of the world, Eastern European women, though generally well educated, were encouraged to pursue humanistic studies as opposed to science and technology (Zavadskaya, 2000). Łobodzińska (1995) argues that there is still a long way to go in order to bring these countries to the Western level of technological awareness, and that "successful functioning in the new free market economy" will require, among other things, "competence in technological applications and in management strategies" (p. 263). Consequently, women should be encouraged to pursue an education in these fields in order to be successful during and after the transition period.

Women and Technology

The communist utopia envisioned better domestic technologies that would ease women's work at home (household appliances, semiprepared dinners, etc.) but always confined them to the role of a housewife. Frink (2001) contends, in fact, that the technological revolution, achieved over several decades in the West and compressed in just over a decade in the East, has left women in former East Germany "further behind" (p. 40) by making redundant the clerical jobs to which they were once confined. Many other such feminized fields (teaching, agriculture) were also severely shaken by the transition. Overall, there have been very few changes in the retraining of the workforce or the desegregation of jobs.

There is a paucity of statistical data in regard to access to IT for all of the developing countries. Hafkin (2003) claims that the only areas for which some gender-specific data are available are Internet access and employment in IT fields; the latter, however, is not very helpful since it shows nothing about the level of employment. Table 1, incomplete as it is, gives an idea regarding gender-specific Internet usage in Eastern Europe.

Table 1. Percentage of women Internet users for some Eastern European countries (USA included for comparison purposes)

Country	Female home Internet users
USA	52
Croatia	42
Estonia	38
Russia	23
Poland	19
Belarus	18
Slovakia	12
Czech Republic	12
Lithuania	10

Source: Hafkin, 2003

Public vs. Private

This distinction used to be state vs. family under communism, in which the family represented an "ersatz public sphere" that was "anti-state and [pro]freedom" (Havelkova as cited in Funk & Mueller, 1993, p. 5). Paradoxically, the collectivist propensity of communism generated a strong contrary reaction, leading to very low levels of civic consciousness, fierce individualism, and a rejection of organized activist movements (Miroiu, 2004; Renne, 1997).

Political Involvement

Studies show a sharp decrease in the political representation of women in the legislative and governmental forums of the newly democratic states (Matland & Montgomery, 2003; Rueschemeyer, 1998): from around 30% to less than 10%, and even below 5% in some countries. Since there is a significant correlation between women's presence in parliament and the visibility of feminist issues and gender equality, women's conspicuous absence from these legislative forums in Eastern European countries decreases their chances to advance their rights and diminishes their citizenship. For some (Gal & Kligman, 2000a), women's increased presence in NGOs (though varying from low efficiency in Romania and Bulgaria to relatively high levels of success in Serbia and Hungary) represents significant political involvement. Matland and Montgomery, however, argue that “political power in a democracy resides in formal institutions” (p. 4) and women are still excluded from such central sites of resolution and change. Despite political underrepresentation, the small steps taken by some countries toward a better representation of women in parliament give Matland and Montgomery reasons for optimism.

Domestic Violence

Reports by international organizations (UNICEF, 1999) or independent researchers show, by and large, that domestic violence is a widespread issue in postcommunist societies, and that the trend is on the rise in the absence of the adoption and strict enforcement of legislation against it. Mass impoverishment and job insecurity, phenomena characteristic of societies in transition, further contributed to the violent treatment of women at home as they made it exponentially difficult for women to leave violent men (cf Nikolic-Ristanovic, 2002). In many cases (Bulgaria, Macedonia, Romania, Serbia), there are no adequate legal means to protect victims of domestic violence. Nikolic-Ristanovic comments that besides hegemonic masculinity, marginalized masculinity (due to poverty, social change, etc.) is a “better predictor of violence against women in the family” (p. 104), and she supports her thesis with ample evidence from research conducted in Hungary, Bulgaria, Macedonia, and especially Serbia. However, more research is needed on the undeniable correlation between social transition and war to women’s vulnerability to domestic violence—research that could boost political action. Only recently in some countries has some legislation in this field been debated, but to date, the issue is poorly understood by the general public and poorly legislated, and social services as well as the legal system are still largely ineffectual in such cases. Still, according to Nikolic-Ristanovic, progress at the institutional level (e.g., police education on issues of domestic violence in Hungary and Bulgaria, and nongovernmental organizations dealing with battered women and sexual abuse in virtually all postcommunist countries, albeit with mixed results) shows that these societies are becoming increasingly more sensitized to the issue.

Pornography and Prostitution

While virtually invisible under communism, prostitution became a matter of public knowledge and (mostly) acceptance after 1989, especially in the context of the retraditionalization of society. This acceptance, however, has seldom led to public questioning of sexual exploitation or the particular circumstances (mostly socioeconomic) that force many young women into prostitution. Similarly, an initial explosion of pornography was considered a right or an unquestioned freedom, and to date, little has changed in that regard (Berry, 1995; Nikolic-Ristanovic, 2002).

Sex Trafficking and Slavery

Nikolic-Ristanovic (2002) summarizes reports from international agencies showing that the number of women from Central and Eastern Europe working as prostitutes in Western Europe and the United States after the end of the Cold War increased dramatically. Although statistics are hard to gather for obvious reasons, an indicator may be the fact that of the number of cases handled by the Foundation against Trafficking of Women in 1997, two thirds were from postcommunist countries. The phenomenon became widespread because of the conflict in former Yugoslavia, which led to the increased presence of soldiers in the region. Women from Bulgaria, Ukraine, Moldova, Romania, and Albania prevail, with transit and destination countries being Serbia, Macedonia, Greece, and ultimately Western countries. Often these women are very young, recruited under false promise but also through kidnapping, and sold and resold multiple times as sex slaves. Surveys show that these women suffer physical and psychological abuse, are illegally confined and isolated, are not adequately paid, if at all, are forced to work more than 12-hour workdays, and are kept in debt bondage. Contributing factors to this are overwhelmingly socioeconomic, compounded by myths about destination countries as well as political and cultural factors (regional conflict, the inefficacy of border police, the globalization of organized crime, a lack of education, etc.). Larger factors, like the construction of gender worldwide, the prosperity of the sex industry, and militarist culture, must also be considered in the analysis of this type of transnational crime alongside the obvious stresses and poverty these societies have to face under transition.

Sexual Harassment

Sexism is still the attitude prevalent in many Eastern European countries, but only recently has the issue of sexual harassment been legislated. In practice, although the phenomenon is fairly widespread, women are reluctant to enter litigation on these grounds (Miroiu, 2004). More education for women as well as a more profound reform of the judicial system should be in place for a real improvement of this issue.

Gay and Lesbian Issues

So far, the only postcommunist country in which there is a stronger lesbian movement is ex-East Germany, where lesbian groups were active since the early 1980s (Frink, 2001). For the most part, lesbian minorities were quasi-invisible; recently they have gained acceptance in countries like Slovenia or Croatia, but are generally nonmilitant as feminists. There is strong conservative opposition against gay rights in many of the postcommunist countries, but currently efforts have been made to align their legislation regarding sexual-minority rights to the European Union standards.

Eastern and Western Women: Misrepresentations or Sisterhood?

From the very beginning of the transition period, authors warned against the "colonialist gaze" that the West, even Western feminism, is prone to cast upon women's issues in Eastern Europe (Einhorn, 1993; Funk & Mueller, 1993; Gal & Kligman, 2000a, 2000b). Eastern European feminists have resisted, in general, both their stereotypical representations in the West and what they perceived as an attempt to unify the discourse of the two feminisms (Eastern and Western) by Western feminists imposing their own agendas and problems, relevant or not to the real issues of the region. Glajar and Radulescu (2004) argue that the Eastern European woman is a liminal case—not quite fully exotic, but not quite fully European—and thus is marginalized and stereotyped.

Other feminists (Bushekin as cited in Renne, 1997) examine the meaning of a global sisterhood and the troubled relationship between Eastern and Western feminists, often fraught with misunderstandings and prejudice, arguing for a continued dialogue between the two.

FUTURE TRENDS

Transition and the so-called democratic-consolidation stage are fluid, ongoing processes. As such, research on women's issues during this period needs to be ongoing and systematic. Women have both lost and gained freedoms in the process, and research to date shows that their political participation (in parliamentary or governmental structures), however small, is still on the rise. More research is needed on the history of feminism in these countries, and, ideally, comparative and integrationist histories of women from now on would take account of such studies. To this end, more translations of works by Eastern European feminists are in order, as well as more collaborative projects between Eastern and Western feminists.

Still, more urgent issues are the prevention of sex trafficking from and through these countries, a more vigorous lobby for abortion rights in the countries where they are threatened, and a better awareness of women's situations in some countries, on which the current literature is astonishingly scarce (e.g., Moldova, Albania, the Caucasus region). Although there is a large variety of ethnic minorities in Eastern Europe, there are little studies to date documenting the issues of minority women.

It is imperative that research be accompanied by political action. Women in these countries need to lobby for appropriate legislation on fundamental women's issues—some of them universal, such as equal opportunities, sexual harassment, domestic violence, abortion and contraception, or lesbian rights, and some of them region specific, such as sex trafficking. Also, better statistics on gender issues are vital. More basic gender data is needed in several key areas such as IT, education, and domestic violence.

Trends regarding women and IT seem promising. Recent Internet-based women's projects in Eastern Europe have met with considerable success lately. Among them are, notably, Women's International Technology Transfer (WITT), a project to train women's organizations in Eastern Europe in using information communication technologies (http://www.witt-project.net), and the Network of East-West Women (NEWW), "an international communication and resource network supporting dialogue, informational exchange, and activism among those concerned about the status of women in Central and Eastern Europe, the Newly Independent States, and the Russian Federation" (http://www.neww.org). These networks are very active in promoting women's rights (such as better access to technology) in the region.

CONCLUSION

The communist treatment of women and the complexities of transition have radically affected the lives of women in Eastern European countries. Much more research and political action are needed, taking into account both the individual circumstances of each country and the global trends that now equally affect the East and the West, to make feminism visible, fight ingrained antifeminism, and promote women's rights.

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KEY TERMS

Birth Strike: Term created by the German media to label what they perceived as a trend by East German women to seek sterilization after 1989 in order to be free to pursue their education, careers, and so forth.

Democratic Consolidation: The period immediately following the initial transition stage in former communist countries.

Ethnonationalism: Strong cultural and regional identity expressed by minority nations within a given state.

Postcommunism/Postsocialism: Terms used interchangeably to denote the period after 1989 in Eastern Europe.

Retraditionalization: The process of returning to traditional, precommunist values in Eastern European countries after 1989.

Transition: The process of converting a centralized communist state system and economy into a capitalist system with democratic institutions and a market-driven economy.

Gender Motives for Web Acceptance and Use

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INTRODUCTION

In principle, males and females should be able to interact in a more gender-equitable environment. However, evidence has proved that behavioural differences due to gender—and other social indicators—may be currently more stressed in the online environments as users become representatives of these social categories (see Jazwinski, 2001; Wolfe, 2001); in fact, several studies have shown that individual differences–regarding gender—play an important role in how information technologies (ITs) are accepted and used.

The gender gap in computers and their applications has interested both computer and social science academics since the early 1980s. However, gender's role within the technology acceptance model (TAM) has been only recently investigated (see Gefen & Straub, 1997; Venkatesh & Morris, 2000). In fact, when TAM was initially introduced (Davis, 1986, 1989), there was no reference to gender differences; as Gefen and Straub (1997) noted, gender has been usually avoided by IT behavioural research. In this sense, we deem it necessary to highlight several main questions.

First, gender differences (1) are potentially critical to our understanding of IT's acceptance and use; and (2) could play an important role in determining how males and females make their decisions about adopting and using them (adapted from Venkatesh & Morris, 2000). Particularly, gender might moderate the influences of intrinsic and extrinsic motives in attitudes and intention to use the Web—dominated by males since inception. More attention should thus be given to gender effects on users' Web perceptions and outcomes; providing more detailed results about gender differences might be increasingly important for academics and Web sites managers.

Second, most of the TAM and gender role research has been basically conducted from an extrinsic-motivation perspective. For instance, Gefen and Straub (1997) (1) analysed gender differences regarding the IT diffusion model and TAM and (2) extended the TAM by also studying the constructs of perceived social presence and information richness addendum among workers using e-mail systems in the airline industry in North America, Asia, and Europe. In turn, Venkatesh and Morris, (1) integrated subjective norm into original TAM-beliefs (i.e., perceived ease of use and usefulness) and (2) analysed gender differences in the relative influence of the extending of TAM constructs on intention to use a new technology (specifically a system for data and information retrieval). Thus, despite the increasing concern for understanding gender's role in Web acceptance and use, a more in-depth analysis should also be made of its moderating influence in: (1) the relation between intrinsic motives (specifically the flow state defined as an intrinsically enjoyable experience) and traditional motives for using the Web (i.e., ease of use and usefulness); and (2) attitudes and intention to use it.

As Venkatesh (2000) notes, there is a significant and growing body of subsequent research regarding the importance of the role of intrinsic motives when using ITs (e.g., Davis, Bagozzi, & Warshaw, 1992; Malone, 1981; Venkatesh & Speier, 1999, 2000; Webster & Martocchio, 1992). Research in the HCI (human-computer interaction) tradition has long asserted that the research of human factors is a key to the successful design and implementation of technological devices, and should include extrinsic and intrinsic motives. Individuals have a full range of opportunities to interact with technologies for different motives that have been characterized as intrinsic, emphasising internal rewards such as pleasure and satisfaction from browsing, or extrinsic, focusing on external rewards including, for instance, incentives and gratifications. It is thus important to consider the different motives based, respectively, on the TAM and the flow experience to understand the acceptance and Web usage (see Sánchez-Franco & Roldán, 2004).

To sum up, researchers have become increasingly aware of (1) the relevance of the non-cognitive aspects in understanding attitudes towards use of the Web and facets of behaviour; and, moreover (2), the gender differences related to acceptance and use of it. Specifically, males and females could differ in the extrinsic and intrinsic motives regarding online behaviour; males and females could be motivated to accept and use the Web for different motives. As Yi and Hwang (2003) suggest, "given that the Web is a relatively new technology and is a richer environment than any other traditional information technology in meeting various personal needs, we expect that these motivational variables will play critical roles in influencing individuals decision to use a Web based technology".

Our main objective in this article is to theoretically analyse and present, by means of a critical literature review, those questions associated with (1) the role of gender in ITs -more specifically, the Web- and (2) the relevance of the non-cognitive aspects (specifically the flow state) in understanding Web acceptance and use. In this sense, this paper is structured as follows: first, in the theoretical background, a brief presentation of TAM and flow state-of-mind is made in order to better position the development of the main part of this paper. Secondly, based on the previous background, we treat the role of gender in Web acceptance and the achievement of flow when using the Web.

THEORETICAL BACKGROUND: TECHNOLOGY ACCEPTANCE MODEL AND THE FLOW STATE

TAM is an adaptation of the theory of reasoned action (see Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975). TAM is considered to be the most parsimonious and robust model in explaining IT use at the individual level and has been widely used to explore (1) attitudes towards ITs and (2) the resultant effect on use. It has been concluded that TAM is a useful theoretical model in helping to understand and explain use behaviour in IT implementation. Moreover, several researches have demonstrated the validity of TAM across a wide variety of ITs (e.g., the Web) (see Moon & Kim, 2001).

According to TAM and its application to the Web, users' acceptance and usage behaviour are determined by their intention to use it, which are also influenced by their beliefs and attitudes towards it.

1. There is a direct and positive relation among users' attitude towards using the Web, their intention to use it and their actual use of it
2. In turn, perceived usefulness and ease of use determine their attitudes toward using the Web
3. Finally, intention to use the Web is viewed as being jointly determined by users' attitude towards using it and their perceived usefulness. These relationships have been examined and supported by many prior studies (e.g., Davis 1989, 1993; Davis, Bagozzi, & Warsaw, 1989; Venkatesh & Davis, 1996, 2000).

Therefore, TAM attempts to predict and explain certain ITs use by posing that *perceived usefulness* and *perceived ease of use* are two primary determinants of its acceptance. Firstly and centering our attention on the Web, perceived usefulness—raditionally the most important factor affecting user acceptance—is the degree to which a person believes that the Web would enhance his task performance (e.g., by reducing the time to accomplish a task or providing timely information); (i.e., the perception that users will want to perform an activity) "because it is perceived to be instrumental in achieving valued outcomes that are distinct from the activity itself, such as improved job performance, pay, or promotions" (Davis et al., 1992). Secondly, perceived ease of use is defined as the degree to which a person believes that using the Web does not require considerable efforts to use it. Moreover, it influences individuals' attitudes through two mechanisms: self-efficacy and instrumentality. Inasmuch as perceived ease of use has an indirect relation with the perceived complexity of use of the Web, it may also affect perceived usefulness. The Web sites that are easier to use would be more useful; i.e. if difficulties associated with using certain Web sites cannot be overcome, then the user may not perceive the usefulness of them.

However, these two beliefs (i.e., perceived usefulness and ease of use) may not, in themselves, be complete enough to explain an individual's Web acceptance and use. Throughout time, there has been an increase of both relevant theoretical and empirical contributions regarding the importance of users' intrinsic motives for understanding their behaviour with ITs (e.g., Bagozzi, Gopinath, & Nyer, 1999; Eastlick & Feinberg, 1999; Hopkinson & Pujari, 1999; Sherman & Mathur, 1997). In fact, the original goal of the activity, or extrinsic reward, could be partly complemented by an intrinsic motivation to use the Web. For instance, users would try the Web because it may provide not only extrinsic efficiency but also intrinsic enjoyment; enjoying oneself—when taking part in an activity—is at the core of the idea of intrinsic motivation. In this context, one of the positive psychological states related to prior affective factors is the "flow" state of mind.

Specifically, flow is defined as the holistic sensation that people feel when they act with total involvement (Csikszentmihalyi, 1975). When individuals achieve the flow state, they become completely concentrated in the activity being developed; they lose self-consciousness, and they feel that they control their environment. Flow is, therefore, a state of mind sometimes experienced by people who are deeply involved in a certain event, object or activity (Lutz and Guiry, 1994). In other words, flow refers to a state of consciousness that is sometimes experienced by individuals who are deeply involved in an enjoyable activity. Thus, a common measure of flow is the level of intrinsic enjoyment of an activity (e.g., browsing), similar to the emotional response of pleasure from environmental psychology (see Koufaris, 2002).

This state of mind may exert a positive influence in the user's acceptance and usage of ITs (e.g., the Web) (see Lee, Kozar, & Larsen, 2003, for a review). Moreover, recent researches have shown that the perceived intrinsic enjoyment has a positive effect on the extrinsic motivation factors (i.e., usefulness; see Agarwal & Karahanna, 2000). Likewise, it has a positive effect on (1) perceived ease of use (e.g., Moon & Kim, 2001; Venkatesh, 1999, 2000); (2) attitude towards using (e.g., Sánchez-Franco & Roldán, 2004); and (3) the intention to use (e.g., Atkinson & Kydd, 1997; Venkatesh, 1999). Thus, assuming these relevant motives in TAM and flow research, there are several reasons to expect that the relationship between motives and Web acceptance could be moderated by gender.

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THE ROLE OF GENDER IN WEB ACCEPTANCE: THE ACHIEVEMENT OF FLOW WHEN USING THE WEB

In general, several studies have found that males show a greater degree of instrumental motivational orientation in comparison to females. Males (1) are motivated by achievement needs and (2) tend to exhibit more of such masculine traits (as identified by different inventories including Bem's Sex Role Inventory). Males are thus more independent or assertive (Hess, Fuller, & Mathew, 2003); males, rather than females, are directed by individualistic tasks (see Venkatesh & Morris, 2000 for a review). On the contrary, females are believed to be more expressive, more skilled at sending and decoding nonverbal messages and, thus, to participate in more nonverbal communicative behaviours (see Briton & Hall, 1995). Females are more aware of others' feelings and concerned with group harmony, consensus building, and interrelationships. To sum up, males could view ITs as tools for performing tasks, whereas females could view ITs as tools for socialization and communication. Moreover, females are 'comprehensive processors' who attempt to assimilate all available information before rendering judgment, while males are "selective processors" who often rely on a subset of highly available and salient cues in place of detailed message elaboration (see Meyers-Levy, 1989; Meyers-Levy & Maheswaran, 1991; Meyers-Levy & Sternthal, 1991).

Specifically, with regard to the topic of this paper, females show a traditional lack of knowledge and experience (i.e., abilities and self-efficacy) in ITs. Females have proved to (1) hold lower perceptions of self-efficacy (see Busch, 1995; Whitley, 1997); (2) show more concern about the risks associated with technologies than males (see Siegrist, 2000); and (3) experience higher levels of anxiety (see Igbaria & Chakrabarti, 1990; Okebukola & Woda, 1993; Whitley, 1997) and more negative feelings than males (Chen, 1986).

Hence, given the lower levels of perceived self-efficacy among females, females (1) could perceive greater risks, so (2) they will be more Web-usage averse. The extent to which this occurs might negatively influence willingness to Web usage. That is to say, females—more Web-risk averse and with a lower self-confidence—(1) will not engage in behaviours without previously adjusting their attitudes; and (2) will take more time to decide to try the Web; females will be less intuitive than males. Expanding the previous reasoning, attitude towards using the Web will, therefore, be a relevant mediator between perceptions and intention to use it among females rather than males.

On the other hand, it is expected that males' Web perceived usefulness may exert a more intense influence in determining the intention to use the Web. In other words, males would *try the Web*, even if they do not have a positive attitude towards using it, because it may provide productivity enhancement (i.e., usefulness). Consequently, males need to perceive the Web as being useful or they will not attempt to use it. On the contrary, females (related to lower instrumental usage) would tend to underestimate the usefulness of the Web. Females, as opposed to males, would not perceive the Web as being relatively useful.

Moreover, individuals' beliefs about their ability to use computers with competence (i.e., computer self-efficacy) is shown to be an important factor to determine their attitude towards using a computer to complete certain task (see Bandura, Adams, & Beyer, 1977; Barling & Beattie, 1983; Webster & Martocchio, 1992). Thus, it could be expected that males' perceived usefulness about the Web will influence their attitude towards it more than females. However, the high perceived risk associated with the Web-usage significantly reduces the females' perception about their self-efficacy in using it, its perceived usefulness, its ease of use and, finally, flow experienced. These low evaluations of perceptions among females can cause an increase in the salience of them in determining attitudes towards using Web (adapted from Venkatesh & Morris, 2000). Females may not be willing to accept a difficult and annoying interface. On the other hand, as we commented above, Meyers-Levy (1989) posed that males were less likely than females to engage in comprehensive processing of all available information as a basis for judgment (see also Meyers-Levy & Maheswaran, 1991; Meyers-Levy & Sternthal, 1991). Males are selective processors who often rely on a subset of highly available and salient cues in place of detailed message elaboration. On the contrary, females are comprehensive processors who attempt to assimilate all available information (i.e., extrinsic and intrinsic beliefs) before rendering judgment. Males (1) will thus engage in behaviours without previously adjusting their attitudes; and (2) will take less time to decide to try, for example, the Web.

Also, gender plays an important role in determining certain aspects related to the intrinsic motives (specifically, the flow state) for adopting and using the Web. In this sense, special attention will be paid to its relation with the achievement of flow.

The area of human computer interaction (HCI) in management information systems (MIS) research has shown that females are motivated by how technology can help other people (its social function), whereas males tend to *enjoy* technology for its own sake (its individual function). In this sense, males are more willing to both intrinsically enjoy and try the Web (less social than other technologies—e.g., e-mail—). Females browse the Web with socio-emotional navigational purposes, while males could enjoy it for itself. This positive subjective experience thus becomes an important reason among males when developing their processes of navigation in the Web.

Certainly, when users experiences flow, their attention is totally focused on their activity. Males focus their attention on a limited field of stimuli, (1) filtering out irrelevant thoughts and perceptions, and (2) affecting their performance positively. Therefore, the causal effect between intrinsically perceived enjoyment and usefulness would imply that flow (i.e., as an intrinsically enjoyable experience) could have a greater effect on perceived usefulness among males.

On the other hand, users with a high level of ability and, consequently, perceived control over the Web (i.e., traditionally males) are likely to feel more able to perform the activity, showing higher comfort levels with developing such an activity. Thus, males would be more willing to experience (1) feelings of enjoyment while engaged in the activity and, in turn, (2) to try the Web more frequently. Males will try a technology—even if they do not have a positive attitude towards using it—because it may provide not only extrinsic efficiency but also psychological pleasure in itself (i.e., flow). Users experience pleasant levels with the activity once a certain level of competence has been achieved (Ghani & Deshpande, 1994). On the contrary, those with low self-efficacy expectations in a particular situation (i.e., traditionally females) will experience unpleasant feelings, such as anxiety, and will behave in unproductive ways, such as avoiding work, and may lack persistence (adapted from Bandura, 1977). That is to say, the intrinsically perceived enjoyment (i.e., flow) does not become an important motive for using the Web. As Csikszentmihalyi (1997) summarise, "when a person is anxious or worried, for example, the step to flow often seems too far, and one retreats to a less challenging situation instead of trying a cope".

Finally, males seek out not only perceived control but also high optimal stimulation and challenging activities and, in turn, lower ease-of-use levels to evoke flow states because they have a basic need for competence. We might expect a lower effect of ease of use (i.e., challenge inversed) on perceived enjoyment for highly involved users and for services which are also used due to intrinsic motivations. On the contrary, inasmuch as females seem to be less Web-confident, and extending the previous ideas, perceived ease of use is likely to be more valued by them than by males. As Csikszentmihalyi (1997) summarise, "when a person is anxious or worried, for example, the step to flow often seems too far, and one retreats to a less challenging situation instead of trying to cope".

CONCLUSION AND FUTURE TRENDS

The theoretical proposals presented in this article analyse the moderating effect of gender on the use of the Web, suggesting how males and females differ in their acceptance and usage of the Web. In general, differences between males and females in the ways in which they approach and interact with the Web are highly relevant to understanding how males and females use the Web in all settings.

Gender role moderates the key relationships in the model; males and females do not value extrinsic and intrinsic motives in the same way when on the Web. Gender differences can have a significant impact on attitudes and behaviours towards using the Web. One could argue that males are driven more by instrumental factors. Also, males could intrinsically enjoy it—i.e. for its own sake. This flow state of mind becomes an important reason for performing an activity among males. On the contrary, females seem to see technology as a means to a more social-end.

As Marcus and Gould (2000) suggest, high-masculinity scripts should focus on the following user-interface and design elements: on the one hand, work tasks, roles, and mastery, with quick results for limited tasks (aspects traditionally related to goal-directed activities); and, on the other hand, navigation oriented to exploration and control (aspects traditionally related to flow-based activities) and attention gained through games and competitions. Likewise, in an attempt to develop positive attitudes among females towards the Web, researchers and professionals might suggest and introduce courses and programs to gain more experience and self-efficacy and, in turn, higher optimal experiences. These suggestions range from changes in pedagogy and perspective (see Bryson & de Castell, 1995), to making the computer (and its online applications), (i.e., the Web) a tool of collaboration between pairs or groups of users rather than individuals (adapted from Littleton & Bannert, 1999), and to giving females a context to the online experience. Therefore, while it seems that these differences are perhaps more enduring than expected, it could certainly be controlled and rendered reasonable by the appropriate use of training-sessions.

In conclusion, intrinsic motives will influence extrinsic motives and, in turn, attitudes and intentions to use. The more males and females intrinsically and socially enjoy using the Web, respectively, the more they will believe that the Web is a useful and stimulating tool. Therefore, flow may also be an important aspect to take into account in the design of future research and Web sites: they must provoke more concentration, arousal, and self-efficacy during the navigation process, in order to make online interaction more equitable among genders.

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KEY TERMS

Extrinsic Motives: Are related to those activities in which individuals engage to obtain some benefits or results, different to those provided by the development of such activities on themselves.

Flow: Is defined as "the holistic sensation that people *feel* when they act with total involvement" (Csikszentmihalyi, 1975).

Intrinsic Motives: Are those based on practising certain behaviour for no reward other than the interest and enjoyment that accompanies it.

Perceived Ease of Use: Is defined as "the degree of which a person believes that using a particular system would be free of effort" (Davis 1989).

Perceived Enjoyment: Refers to "the extent to which the activity of using the computer is perceived to be enjoyable in its own right, apart from any performance consequences that may be anticipated" (Davis et al., 1989).

Perceived Usefulness: Is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989).

Self-Efficacy: Is defined as a person's belief in their ability to accomplish a specific task (Bandura, 1977).

Gender Recruitment Issues in the IT Sector

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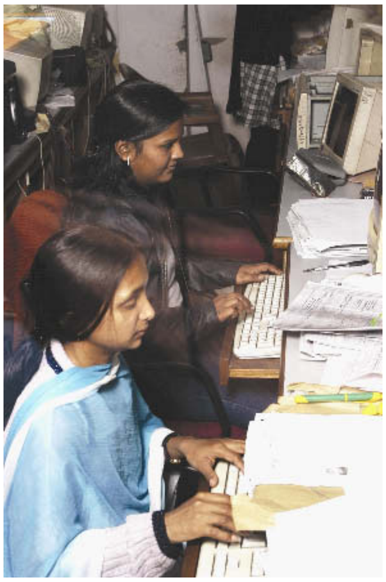
INTRODUCTION

In India, low literacy rates, traditional gender roles, lack of marketable skills and lower educational levels make it difficult for women to find employment, especially skilled or technical jobs. Women often must settle for jobs that are low paid and require little skill. The problem is compounded for women from disadvantaged backgrounds, who are often forced to work in the informal sector of the economy, which affords little job security or growth potential. The information technology (IT) sector has become a driving force in India's economic development, accelerating job and revenue creation. As opportunities continue to grow, IT jobs have the potential to create financial stability for greater numbers of employees. Lack of adequate training, high illiteracy rates and low familiarity with computers and the Internet have kept women from entering the IT job market in significant numbers so far, despite the fact that women employees bring other valuable qualities to the workplace, like loyalty, attention to detail and good interpersonal skills.

Recognizing the benefit of increasing the number of women in the workforce, Datamation Consultants Pvt. Ltd. is using IT training to extend job opportunities to women from socially or economically disadvantaged backgrounds. These women not only lack the technical training and skills that would otherwise allow them access to these jobs, but often lack even basic education. Through an innovative public-private partnership program, Datamation works with local non-profit partners to give these women the training they need, and then recruits successful trainees for full-time jobs within the company.

Figure 1.



BACKGROUND

Established in 1987, Datamation is a multi-service data processing and consulting firm, offering a suite of services including data processing, software development, medical and business transcription, data conversion, direct marketing and CRM, CD/DVD reproduction, imaging and GIS processing, and project management. Datamation provides services to both Indian and international corporations, including Fortune 500 companies. The work extends the IT sector into underserved areas of the country while generating higher profit margins due to lower operating and labor costs.

A major company with ISO 9000 status now under review, Datamation has a strong commitment to social responsibility. The logo on its Web site (www.datamationindia.com/) flashes a rotating tag line with slogans like "At the convergence and intersection of information technology and human development" and "Committed to the creation of employment opportunities for deprived youth, women and physically handicapped." Datamation views its activities not as charity, but as social investment that simultaneously benefits individuals, communities and its own business interests.

TRAIN-AND-HIRE PROGRAM

Datamation's train-and-hire program is based on an extensive public-private partnership between the company and more than a dozen private non-profit non-governmental organizations (NGOs). Partner NGOs are selected according to a number of criteria, including the strength of their institutional capacity, seriousness of their mission to create sustainable job opportunities, efficacy and impact of their efforts in serving their target communities and their ability to implement low-cost IT training courses.

Partner NGOs offer free or low-cost 6- to 8-month IT training courses to marginalized groups of women. These courses cover basic computer operation; various software applications, including Microsoft Word, Excel, Access and Power Point; and the fundamentals of software development, though trainees are not expected to become programmers. Efforts are made to provide training in local languages, as English is not widely spoken among students from disadvantaged backgrounds. Knowledge of English is not a prerequisite to hiring. Since the overall goal of the program is women's empowerment and personal development, the aim is to provide life skills training in topics such as healthcare, communication skills, professionalism and work ethic, and knowledge of worker's and women's rights. Successful graduates of the training course can apply for entry-level jobs with Datamation. Recruitment tests examine technical skills, numerical and quantitative analytical aptitude, and written and spoken communication skills. They also assess professional attitude and work ethic, and the ability to cope with the stress of working long hours at a computer terminal. Women are not given preferential treatment in the hiring process and must pass the same rigorous recruitment testing process as all other hires. Datamation is committed to hiring women who have the skills and qualifications to succeed on the job; compromising hiring standards would not be of benefit to the company.

An ongoing mentoring and training system has also been established to ensure the continued success of new employees. Mentoring focuses on professional etiquette, stress management, communication skills, life skills and new developments in technology as they relate to their jobs. The cultural transition that occurs once the initial hire is made often requires daily attention, and mentoring has been seen to play a critical role in employee retention and success.

MANAGEMENT

Datamation maintains a close working relationship with its partners, especially the Datamation Foundation. There are regularly scheduled staff meetings, and frequent opportunities for communication and feedback. The staff of Datamation Consultants regularly works with Foundation and other partner NGO staff, resulting in an efficient hiring process following the training program. The Datamation Foundation acts as an umbrella organization for the non-profits in partnership. Under its guidance, the NGOs have developed a platform for networking and creating common strategies and objectives. Established as a private non-profit entity, the Datamation Foundation was set up by Datamation Consultants as a way to focus on Datamation's social goals in a structured and independent manner. The Datamation Foundation's stated mission is to provide social services and outreach to marginalized groups in India through innovative uses of information and communication technologies (ICTs) and the creation of employment opportunities. The main activity that supports its mission is working with Datamation Consultants on the train-and-hire program.

Datamation Consultants also provides technical support to partner NGOs in support of their wider organizational needs. This may include hardware and software development, Web site design and maintenance, and technical support. Datamation conducts a needs assessment of each new partner NGO to determine the extent and type of technical support needed. Dedicated staff hours and resources donated for all partner NGOs are estimated at a cost of $3,000 (United States (U.S.) dollars) per month, including overhead and administrative costs. Funding in the form of cash grants is not a major provision of Datamation's partnerships with NGOs, though some funds may be disbursed on a case-by-case basis. Partner NGOs have independent funding sources. The Datamation Foundation is entirely funded by Datamation Consultants. The train-and-hire program has proven to be very cost effective for Datamation Consultants, because it creates a loyal employee base and therefore reduces manpower attrition rates. However, Datamation Foundation is currently seeking outside donor funds, especially for the vocational training component.

FUTURE TRENDS

Driven both by changes in social norms and financial necessity, an increasing number of Indian women are seeking employment outside the home. As women are increasingly seeking independent identities and building professional capacity, many Indian households depend on a woman's supplemental income to support an immediate and extended family often living under one roof.

In the IT sector, highly-trained professional software and hardware engineering and project management positions are still typically filled by male employees, but there are vast numbers of jobs that are less technically intensive for which Datamation considers women well suited. Much of the work involved in data processing, for instance, is repetitive and detail oriented, and requires diligence and a stable workforce. While it is difficult to generalize about specific aptitudes across gender, social conventions in India often influence women's greater need for balance between their professional and family lives. As such, women may be attracted to jobs that are not as professionally sophisticated but are less demanding or time intensive. Moreover, a large number of women have good interpersonal skills and are often able to adapt well to new cultures and languages. These skills are needed in India-based business-process outsourcing and call centers that serve foreign clientele.

Of Datamation's nearly 2,000 employees, 35% are women, and 85% of these women are from disadvantaged backgrounds. In India, women working in the IT sector earn approximately 88% more than those in non-IT jobs, and Datamation's salaries reflect this trend. A newly hired trainee can expect to earn U.S. $60-$70 per month starting salary, with growth potential to U.S. $100 per month after the first year of successful performance. Over the next few years, Datamation expects to add more than 3,000 additional jobs, with a significant percentage of those available to successful graduates of the training courses.

CONCLUSION

Integrating women from backgrounds of extreme poverty, marginalization and even abuse into highly competitive professional environments has not proven to be a straightforward task. Receiving job training is only the first step towards making lasting changes in these women's lives. In addition to acquiring new job skills, the women may need to make enormous changes in their attitudes, behaviors and expectations, and this often requires a significant amount of consistent time and effort, both for the women themselves and for the counselors and mentors provided by Datamation Foundation. Investing in these women's futures is not a one-time event; rather, Datamation recognizes this as a long-term, ongoing development endeavor. Professional development and continuing technical training is provided to all of Datamation's staff, but Datamation has found that more consistent technical "refresher" courses were needed for the women hired from this program. Lack of good primary education and low familiarity with technology means their need for retraining is higher than other recruits.

The staff time needed for this ongoing support does incur additional cost to Datamation, but a large bulk of the interaction and retraining is supplied by the Datamation Foundation's board members and volunteers, and thus does not subtract significantly from the company's bottom line. Lack of government support has also been a challenge. There is a need for adequate transportation for workers, as well as subsidized quality day care facilities. Day care and a connectivity infrastructure that would facilitate telecommuting would help address the challenge of post-maternity retention. Currently, only about 40% of women employees continue working after their first child is born, which represents a significant loss of the female workforce and associated training costs.

KEY LESSONS

Datamation is an example of how business model innovation involving the use of ICTs can accelerate social development and corporate success. Datamation's social investment efforts expand the traditional definitions of corporate responsibility and corporate citizenship. Investment in training provides significant benefits to the workers while also helping to ensure that the company has a strong, skilled workforce. And the results at Datamation have been very encouraging, while the majority of the female workforce hails from underprivileged segments of Indian society, the training and support services provided by partner NGOs enables them to function as loyal and disciplined employees.

The success of Datamation's program lies in its innovative public-private partnership. The partnership allows each party to leverage its comparative advantage to achieve greater benefits; it creates a cost-effective means of achieving parallel social objectives for both Datamation Consultants and the partner NGOs. Through this partnership, Datamation is able to bring minority and disadvantaged women into its organizational mainstream, a segment of the population that does not have substantial access to employment opportunities elsewhere. The model also highlights the potential of ICTs to penetrate poor and uneducated social groups, thereby transforming individuals and communities. Datamation's train-and-hire program offers a tangible and profitable way technology can be used by people at the bottom of the economic pyramid. Bridging the digital divide implies providing access to technology in ways relevant to people's lives, defeating the notion that technology is the exclusive domain of affluent or educated populations.

KEY TERMS

Customer Relation Management (CRM): An information system used to manage relationships with organizational customers.

Geographical Information System (GIS): An information system that combines database management with location data.

Non-Governmental Organizations (NGOs): Private and not-for-profit organizations not affiliated with governments or institutions.

G

Gender Sensitive Design Practices

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INTRODUCTION

To what extent and in what ways do companies take gender into account in their design decisions? In the past, commerce has been criticized for designing for the dominant group in society—the notorious young, white, able-bodied, highly educated male—to the exclusion of user groups who do not fit these criteria. It has been argued that by designing for everybody, designers in fact unconsciously follow the male norm in society. The question of this article is the following: Which dominant design methodologies can be found in practice when designers make products aimed to include women? The ways in which gender gets drawn into the design process for a large diversity of ICT products will be reviewed, such as for games, Web sites, mobile phones, and computer parties.[1]

BACKGROUND

When designers develop a new product, user representations, or images of the end users of their product, are (un)consciously produced with the help of implicit or explicit techniques (Akrich, 1995). Implicit techniques are based on statements made on behalf of potential users, whereas they are directly involved when explicit representation techniques are used. The implicit techniques are by far most popular amongst designers. Designers, for instance, refer to commonly held beliefs about the way men or women are; in other words, they rely on stereotypes. Almost as important is the implicit representation technique called the I-methodology, in which the designer uses himself or herself as exemplary for the user. In some cases, explicit user representation techniques are used, for example, by testing the product on potential users or by allowing user feedback after the product has been introduced. Each of these dominant gender-sensitive design practices as distinguished by reviewing multiple case studies on design practices will be described and discussed for their effects on gender.

Relying on Stereotypes

For many designers who aimed to include women as end users of their products, an important goal was to define in what ways girls are different from boys. Many designers were convinced that some things just belong to women's or girl's products, "like fashion and beauty" (Hestflatt, 2003, p. 101). Some founded these beliefs on generally held convictions about "the way women are with ICT," or stereotypes (Hofman, 1995). In some cases, they started with a literature study on gender differences, using books and reports that have been extensively criticized by feminists for the way they dichotomize and naturalize perceived biological differences between men and women (Rommes, Stienstra, & Oudshoorn, 2003). Many designers looked at comparable products and the way they target women. Most often, popular print magazines aimed at girls or women were used as sources of inspiration. As a result, the interfaces of these girl games "[have] similar aesthetics to the girls magazines that inspired them, with lots of colour (especially pink!), cartoon images, and non-rectangular windows" (Stewart, 2003, p. 15). The result was that they repeated rather than transformed existing stereotypes.

By relying on stereotypes about women, designers attempted to construct an image of their future users as different than the audience they had been designing for before. Hence, no matter what the precise target group was—older women or girls, highly educated women or women living in disadvantaged areas—the same general beliefs about what women want resurfaced. All women were represented as being neither interested nor skilled in technology, and as preferring user-friendly (i.e., simplified) interfaces. Moreover, women were, according to the designers, not into technology for fun, but for directly useful applications (Rommes et al., 2003; Stewart, 2003).[2] Also, women were supposed to be interested in open play forms without many rules, in community building, and in interaction. Last but not least, women prefer feminine content, such as fashion, horoscopes, and relationships, presented with feminine aesthetics. Seeing how often these images about women are repeated in ICTs, these are very persistent general ideas about what women are or what they like that seem to resurface whenever designers design a product for women (Lagesen, 2003; Shade, 2000).

There is a positive and a negative side to the focus of companies on the ways in which women are different from men. On the one hand, a focus on what women want could serve to strengthen and give value to feminine-connotational skills and preferences (Cassell & Jenkins, 1998). On the other hand, by developing a product based on "typical women's interests," designers run the risk of reinforcing and reinscribing perceived gender differences rather than "transforming gender" (Sørensen & Stewart, 2002, p. 28). Moreover, designers' beliefs about women do not often conform to the skills, preferences, and experiences of most women.

The I-Methodology

In virtually all product design processes empirically described in the literature, be it computer games, Web magazines, or mobile phones, the I-methodology was used (Akrich, 1995; Gansmo, Nordli, & Sørensen, 2003; Oudshoorn, Rommes, & Stienstra, 2004). In other words, the designers based their design decisions on what they would like to use themselves. The use of the I-methodology has been considered problematic in the context of gender-sensitive design because most designers are male and run the risk of making a design that men will like.

However, in some cases, the I-methodology was used in a reflective way as several companies consciously asked women to join the design team. The project leader of a game for girls argued for the inclusion of women in the project team by suggesting that the female project members "would surely know what seven-year-old girls like and prefer. They have been there themselves" (Rommes et al., 2003, p. 197). In several other projects, the introduction of more female employees happened less consciously but still had some effects. For example, Gansmo, Nordli, et al. (2003) found a positive aspect of having a female developer of a computer game: "the only female character…has been made a bit more visible in the game because the female developer thought it was important" (p. 129). In some cases, the fact that a woman was responsible was the main reason a project to include women started at all (Lagesen, 2003; Pitt, 2003).

There are two aspects that need to be taken into account when reflective I-methodology is used. First, the division of tasks between men and women in the design process is often done in stereotypical ways. This unequal distribution may lead to, for example, having female-connotated content in an interface with masculine-connotated preferences. Moreover, in many cases, women have less to say about the design because they are not placed in responsible positions or are junior recruits and have no direct input into the development of the site (MacKeogh, 2003). Hence, if women are introduced in the design process as a way of introducing a more reflective form of I-methodology, the hierarchical position in which a person is introduced is relevant.

Second, not every woman is representative of the women that the designers aim for. Even in cases where female designers are similar to the end users in relevant areas, such as in their age, sexual identity, race, interests, or preferences, the mere fact that they are part of and socialized in a design team with its own (masculine) culture, have access to the latest technology and to a network of skilled computer users, and are interested and skilled in the use of technology makes them very different than potential end users (Rommes, 2002c).[3] It may very well be that education in participatory design techniques is more relevant in deciding whether someone knows what (female) end users want than the mere fact that someone is of the same sex as the targeted end users. All in all, even the reflective I-methodology needs to be used with care.

User-Participatory Design Techniques

The inherent problems of using implicit representation techniques may by now be clear. As an alternative, explicit user-representation techniques such as testing products on potential users or participatory design techniques are suggested. These have sometimes been called feminist strategies (Balka, 2005; Cassell, 1998; Greenbaum, 1991). Several of the companies studied invested time and energy in finding representative end users and in finding out what their preferences were. The company Art Plant, which was in the process of developing a game for horse-enthusiast girls, has "been to a stable, talked with girls there, and asked them what they would like in a game" (Gansmo, Nordli et al., 2003, p. 131). The designers of two games for girls tested their games at a school (Rommes et al., 2003; Stewart, 2003).

However, studies of design cultures in ICT companies in Europe show that user involvement in the design process is rather an exception. In practice, designers hardly involve users in the design process (European Commission, 1998; Offenbeek & Koopman, 1996). The priority that is given to user testing is small, and even design teams themselves complain of time and money constraints on user testing, let alone on other more participatory forms of design (Fortunati & Manganelli, 2003). Although these constraints are very real, they are also showing a lack of priority in involving users in any way in the design process. User involvement seems in most cases to be limited to the option of users "voting with their feet" or the "consumption junction" after the product has been put on the market (Schwartz Cowan, 1987). We could speculate that the lack of involvement of users during the design process is caused by users' lack of resources as they do not have a social or formalized position in the design process, they do not have economic resources that are of relevance in the process, and they often have a lack of relevant (technological) knowledge. Hence, they cannot obtain any sort of control in the process (Clarke & Montini, 1993; Lehoux, Sicotte, & Denis, 1999; Pain, Owen, Franklin, & Green, 1993).

Moreover, often user testing is only done toward the end of the project, when the main design decisions have already been made. This seriously constrains the influence end users can have on the design. The earlier potential users are involved in the design process, the more influence they can still have on the design of the product and the less chance that designers find out too late that they are on the wrong track. In addition, the way potential test users are recruited is not always done systematically and is not always aimed at reaching representative users. Often, members of the family, employees in the office, or people that happen to be around the office are asked to perform some tests (Mackay, Carne, Beynon-Davies, & Tudhope, 2000; Rommes, 2002a). Even if companies do pay attention to the selection of users to test, inadvertently things may go wrong that make them less comparable with the users designers want to reach. TILab, an official user-testing laboratory, created research professionals that do no longer seem representative of the end users (Fortunati & Manganelli, 2003).[4] Who are the end users anyway? Should nonusers or other implicated actors also be involved (Rommes, 2002b)? Clearly, the issue of the selection of representative end users remains an important and complicated one.

Moreover, for commercial companies, the interests of the financiers may precede the potential wishes of the (female) end users (Rommes, 2002a).[5] Designers of magazines or of Web sites, for example, need to take the wishes of advertisers into account, which according to Fortunati (2003, p. 286), "was one of the main reasons that women's magazines pay so much attention to beauty and fashion". Similarly, Rommes et al. (2003) and Stewart (2003) found that the designers of games for children were very interested in what parents would want to buy for their children as they had the money to spend for their children. The choice of giving a game platform for girls a pinkish colour was made to indulge the expected wishes of parents even though participatory design techniques had clearly revealed that the girls themselves preferred black or metallic colours.

FUTURE TRENDS

A new way of testing products on users or of getting feedback on design has become available as a result of the "interactive features of the [W]eb" (MacKeogh, 2003, p. 393). Users reporting their preferences, problems, and wishes back to the designers via the computer and the Internet were found for Web magazines and Web sites in Italy, Norway, and the Netherlands, and for the development of several games. The feedback users gave has in several instances changed the image the designers had of their users, and in some cases influenced design decisions (Hestflatt, 2003;

MacKeogh).[6] Although these interactive features of ICTs seem to be very effective in giving a larger influence to users, the users that give feedback on Web sites are a specific group of users. They are per definition more active, engaged, and articulated than ordinary users. By solely focusing on their wishes and demands, designers run the risk of ignoring potential wishes by users that are less good in articulating their demands. Or, more fundamentally, designers run the risk of ignoring and excluding potential users that are still nonusers of the Web site.

CONCLUSION

In this article, three dominant gender-sensitive design methodologies have been found in design practices, namely, relying on stereotypes, the I-methodology, and user-participatory design techniques. Each of these has some advantages and some disadvantages. Relying on stereotypes revalues feminine-connotational values and interests in present Western society, but at the same time reinforces and reinscribes them. The I-methodology, which is presently one of the most commonly used design methodologies, may result in replicating the masculine norm. However, in the context of gender-sensitive design practices, in some cases it has led to the involvement of women in design teams, although they were not always placed in a position where they could make a difference. Even this more reflective use of the I-methodology has some practical and theoretical consequences as it again equates women with femininity, and because designers, even female designers, are per definition not in every relevant way representative of the end users they aim to represent.

In general, one could say that designers do not necessarily design for the end users, but for the people that pay, for what they prefer themselves, or for what the stereotypical woman would prefer. The exception to this rule could be made by what sometimes has been called feminist direct user-involvement techniques, in which potential users are involved in the design from an early point on. In the rare cases where this approach has been adopted, it seems to have helped in creating a more nuanced image of what women want and in empowering female end users. Again, some practical problems come up with these techniques as designers need to pay more attention to the selection of potential users on which user tests are performed to make sure that they are representative of the end users designers aim to reach.

There is a more theoretical problem with user-participatory design. For even if users are involved in a timely phase in the design process and are given the means to make a difference, and even if designers find users that are representative of their target group at all, the question still remains: What kind of democratic values are being pursued? Do designers follow the wishes of the majority of the representative test users, or do they aim to protect the interests of the wishes of some of the minority test users? And, does such a process lead to a viable product? As long as in practice user-participatory design techniques are hardly ever used, these questions remain, empirically, unanswered.

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KEY TERMS

Explicit User-Representation Techniques: Techniques in which information about potential end users of a product is directly collected from consumers (e.g., with questionnaires or by feedback on design), and/or in which potential end users are directly involved in the design process (e.g., with participatory design techniques).

Feedback on Design: Users give feedback to improve a product after it has been introduced. Increasingly, feedback is obtained via the Internet.

I-Methodology: Designers base design decisions on their own individual preferences.

Implicit User-Representation Techniques: Information about potential end users is based on statements made on behalf of the users (e.g., by referring to other products or by using the I-methodology).

Participatory Design Techniques: Potential end users are involved in the design process (e.g., by having users participate in product brainstorms or prototype discussions).

Reflective I-Methodology: Designers reflect on the areas in which they are similar to the end users and only use the I-methodology when making design decisions that have an impact on these areas. In addition, designers that are similar to the end users are introduced in the design team.

Relying on Stereotypes: Design method commonly used when designers are faced with an unfamiliar target group.

User Representations: Images designers construct of the end users that become incorporated in the design of their products.

ENDNOTES

1. The comparison of findings of literature in this article is based on but not restricted to case studies from the large-scale European project Strategies of Inclusion: Gender and the Information Society, conducted between 2002 and 2004 in Ireland, the United Kingdom, Italy, Norway, and the Netherlands. The research was supported by the European Commission, 5th Framework, and the Information Society Technologies (IST) Programme (IST-2000-26329; see also Faulkner & Merete, 2006). The 48 case studies have been collected in three volumes (Lie & Sørensen, 2003; MacKeogh & Preston, 2003; Oudshoorn, Rommes, & Slooten, 2004).
2. Other research has shown that fun may be a crucial inclusion strategy for women, and that girls do like to play (Gansmo, Lagesen, & Sørensen, 2003).
3. Their knowledge is situated differently than that of the end users.
4. This is a more common finding: In practice, many user studies are done with groups of professionals (often software engineers; Pain et al., 1993).
5. Other groups that designers have to take into account in addition to the end users are, for example, competitors selling similar or different products, regulatory actors such as the government, and other financiers such as publishers and educators.
6. In one case, staff even used the feedback of the users of a women's Web magazine as input for the printed magazine (Slooten, 2003).

Gender, Education, and Video Games

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INTRODUCTION

The scope of this article is to analyze educational multimedia games from a gender perspective.

Our society is changing, moving toward information and communication technologies (Castells, 1997). Schools are not exempt of this change and computers in the classroom begin to be common. This new learning tool needs to be critically evaluated by teachers. The gender construction in the world representations offered by educational multimedia should also be evaluated.

BACKGROUND

Towards the end of the 1990s, an American movement called *girl's games* appeared. This trend studied those multimedia products geared for girls under 14.

The interest in computer games for girls originates from a confluence of interests between the feminist movement that tried to improve women's situation within digital technology, and entrepreneurs of the multimedia sector, that discovered a new market sector for its products in young girls (Cassell & Jenkins, 1998).

Feminist studies are centred on the representation of women in computer games from a triple perspective: as characters (how they are portrayed, to what roles they are attributed, in what scenes they are placed, etc.), as producers (which is the proportion of programmers, illustrators or video game company directors) and as users (which is the design, the contents and the type of interactivity with the game they use). Simultaneously, large computer game firms commission studies concerning young girls' preferences with respect to the characters, colours, activities, game styles, etc.

The first game specifically for girls entitled, *Hawaii High: The Mystery of the Tiki* was produced in 1994 by the company Sanctuary Woods. Although it was not a sales hit, it introduced characteristics (like brilliantly coloured graphics and complex opposing storylines in which values like friendships and social relationships play an important role) that were common to other girl's games of this first generation. But it was not until 1996, when *Barbie Fashion Designer* appeared and sold more than half a million copies in the first two months, that things changed for the games' market for girls. It was seen at that time that software specifically for girls could triumph as one for boys. But not all producers agreed on the same definition for girls' games. Within this label, there coexisted the traditional games in which a girl identifies with the most traditional female norms—like *Mattel* games with *Barbie* as the star—and the "non stereotyped" games (Escofet, Espanya, Herrero, & Rubio, 2000) which were new multimedia products that were designed and produced at the end of the 1990s by companies like *HerInteractive, Girl Games, Girltech, and Purple Moon*. The one characteristic all these companies have in common is that they were managed by women, hired many female staff, and were motivated by the desire to transform gender relationships within American culture and to create a potential new market. In 1997, they signed a deal which was an example of the collaborative style that they followed. This resulted in the creation of *GIRL*, the *Girl Interactive Library*, with the intention of familiarizing girls with the technological market. Its Web page, *Just4girls*, was an important centre of information about its software proposal for girls, that was based on the style of current and personal themes like making decisions concerning family relationships or friendships.

Even though there is a claim by the game industry that they make decisions based on research and that they incorporate female gender findings into their products, the reality is that multimedia games "for girls" present friendly environments where female stereotypes are reinforced. There are industries that have tried to fulfil the lack of software for girls, but although they have very good intentions, they classify as "girl's games" those that show them interested only in make-up, shopping, and dating. They even include specific make-up products in the packaging of the games. This has been criticized by authors such as Rubin (1999, p. 3), when saying "Viewing girls as motivated primarily by social status and consumerism is just as bad as assuming that all boys will be captivated by violence."

Many authors will not grant to Barbie, the super-feminine symbol, a possible relevant representation to be made in order to attract girls to the new technologies, a prize that seems too high because it maintains female stereotypes. Authors like Turkle (1995, p. 20) say "computers don't just do things for us, they do things to us, including to our ways of thinking about ourselves and other people," and de Castell and Bryson (1998, p. 251) ask us about "Are we producing tools for girls, or are we producing girls themselves ... ?"

Another important criticism is that the "non-competitive relationships" that these games present seem to move away from a sense of ambition and effort, indispensable to occupy leadership positions in the working environment (Eisenberg, 1998).

Not all authors share this negative view. There are others that believe that any use of software programs can increase girl's interest in technology. This is the view of the industry. Conversely, Beatto (1997) and Subrahmanyam and Greenfield (1998) believe that this type of use can be detrimental to girls. They sustain kids that play with computers spend a lot more time at the computer than those that only use it to do homework. This extra time allows them to develop better skills and the flexibility to experiment with the computer.

Subrahmanyam and Greenfield (1998) analyze *Barbie Fashion Designer's* success. They sustain that a game that engages girls is a lot more than one with a female character. They conclude by saying that Barbie's success is related to the outcome of the game, one without a specific goal, converting the computer in a tool and facilitating that which girls do the most.

In this setting, the girls that play the game are the designers, not Barbie, they are the active protagonists of the game. And this, combined with the types of environment rejected by girls, because of their aggressive content, is the main reason why girls like this game, even though it includes many stereotypes. These authors believe this is a prosocial game, one that is not violent or aggressive, as the main games available in the marked.

To conclude, we still need to look at a third alternative. There are games susceptible to attract girls and boys in the same way and can be placed in the same category rather than in opposite ones. They are neutral videogames with regard to gender stereotype, based on non-violent contents, and with activities geared for a non-stereotypical user regardless of gender.

But, what are the boys and girls preferences when it comes to computer games?

MAIN THRUST OF THE ARTICLE

Investigation in the area of computer games and gender is relatively recent, in that there still does not exist a large number of studies. In spite of this, the studies that have been done show a similar development, focus, and conclusions. The studies have been traditionally made of two types: on the one hand, an analysis of the games themselves with respect to content, characters, themes and graphics; and on the other hand, a study of the game users with relation to variables such as attitude, competence and preferences. Methodologically, most of the investigations have been performed by means of studies such as ex-post-facto, observational, co-relational, and comparative-causal enquiries and analyses.

The analysis of computer games has always revealed the presence of a higher number of masculine characters and the representation of the stereotypical roles for both sexes—masculine dominance and action vs. feminine submission and passivity—and even the female characters as sexual objects or ornaments (Urbina, Riera, Ortego, & Gilbert, 2002). The predominant themes are women being rescued, revenge, and especially good guys against bad guys (Matthis, 1996), with designs resembling games that emphasize eye-hand coordination, rapid reflexes and action (Huff & Cooper, 1987). The visual environment is generally full of primary colours and suspenseful or dangerous atmospheres, and the auditory environment is characterized by its excessive and monotonous sounds.

Studies concerning game users reveal the following data:

- The attitude of the boys towards computer games (and technology in general) is more positive than that of girls (Escofet, Herrero, & Rubio, 2002; Levin & Gordon, 1989), from the age in which the process of socialization begins and social groups treat boys and girls in a distinct way. These groups send different stereotypical messages to both sexes (Tyack & Hansot, 1990).
- Boys are more independent when playing video games and more competent that girls, especially in games that are more difficult (Escofet et al., 2002).
- Boys and girls prefer games that depict characters and roles traditionally attributed to their gender. Even though acceptance on the girls' part for boy's games is higher than the reverse, not all the girls refuse to play boy's games and they eventually like them while it is difficult to find the contrary (Escofet et al., 2002; Jacobs, 1994). A possible motive for this is because the videogame industry was inclined to produce primarily for the male public. On the other hand, boys and girls equally liked the neutral, non-stereotypical games (Escofet et al., 2002).
- Girls prefer to play games with a low level of frustration. This implies games where they can move freely (without needing to complete one screen in order to pass to another) are not monotonous and are without excessive noise. They give priority to collaboration and functionality over competition and they value games with argument lines that combine different types of activities. They like games in which they can make personal discoveries, with environments that are exploratory, creative, safe, and amicable. They like the drawings of people, animals, and plants, with a full range of colours and auditory environments where the quality of the voices and the music dominate (Escofet et al., 2002).

FUTURE TRENDS AND CONCLUSION

The social impact and importance that videogames have been given in the last few years has risen, and the theory has followed the same path. We could cite various examples, like the creation of the scientific magazine *Game Studies* in the famous MIT and the publication of books about the educational value of videogames (like Gee, 2003), among others.

Console tables and videogames can be converted, most of the time, into children's first opportunity to access the multimedia era. In our society, computer games constitute a fundamental part of popular culture for boys and girls (Provenzo, 1991). And many are the authors who make convincing arguments about the importance of having children's popular culture in their educational environment. Leggo (1993) affirms that television and computer games, among other electronic media, are worthy of attention in the classroom because to ignore popular culture would be like constructing a high wall around our schools.

But it is not enough to promote the introduction of computer games in schools. Educators should be very aware that these games, being part of popular culture, reproduce many of its traits, in particular those that make reference to gender.

Now at a moment when parents demand technological learning and when the administration is especially mindful of the incorporation of technology into the school world, it becomes very clear that it is necessary to consider -from the point of view of gender—the implications of the use of technology in the classroom.

If we do not want to perpetuate the circle of inequality and exclusion, we must attempt to provide boys and girls with computer experiences that reflect the multitude of uses that this tool has, among them, playing. Girls must get the attention and the support that until now has not been met in the multimedia industry.

G

It is possible to find games with characteristics that attract boys and girls, despite gender. These "good" games share diverse properties, for example interesting stories, attractive stars, clear rules and objectives and assorted activities and strategies. These characteristics, among others, make a computer game motivational, so boys and girls seat attentively in order to better themselves and become better players.

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KEY TERMS

Computer Games: Multimedia software that combines educational and recreational uses.

Girl's Games: American movement that studies those multimedia products geared for girls under 14.

Information and Communication Technologies (ICT): technologies based on multimedia and telecommunication.

Multimedia Software: Application that combines in one support different kinds of information presented in a non-linear way.

New Technologies: See ICT.

Videogames: See computer games.

Gender, Gaming, and IT Careers

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INTRODUCTION

Computer Games to Keep Women in the Pipeline?

Many IT researchers have noted the disturbing trend of an *incredible shrinking pipeline*; this pipeline represents the number of women who are involved in computer and technology fields from high school continuing onto graduate school or professional careers (Camp, 1997; Gorriz & Medina, 2000). A closely related phenomenon is how girls' interest in computer and video games tends to dwindle during childhood. Researchers feel that computer games have provided "a significant impetus for many boys to become more acquainted with computers … [for] young people who play games are more likely to enter computer-related careers" (Agosto, 2004, pp. 11-12). It seems reasonable, then, that computer and video games provide an easy lead-in to computer familiarity, comfort and literacy (Cassell & Jenkins, 2000).

Preschool children of both sexes demonstrate equal interest in computer games, but as girls mature, they lose interest in gaming (Agosto, 2004; Comber, Colley, Hargreaves, & Dorn, 1997). The reasons for this are uncertain. Perhaps it is partly because of the way women are often under represented in games—only 16% of the characters in the bestselling games are female—or when they are represented, the characters are portrayed unrealistically or negatively (Douglas, Dragiewicz, Manzano & McMullin, 2002). Female game characters are frequently depicted as damsels in distress, scantily clad, objectified rewards to be won, or passive bystanders (Provenzo, 1991; Douglas et al., 2002). Cassell and Jenkins (2000, p. 6)) see this portrayal as a "prime example of the social construction of gender."

Another reason may be the lack of enough compelling and attractive content tailored to young girls (Gorriz et al., 2000). Perhaps it is not that girls innately dislike video games, but there are simply too few titles to choose from. Statistics show that women actually do enjoy video games – in fact, 43% of all gamers today are women, but most of these women are over the age of 18 (Entertainment Software Association, 2005). When women do play games, they tend to play online games and social games such as Electronic Arts' *Sims Online*. While a game like *Sims Online* is gender neutral, it is noteworthy that more women (56%) actually play this game than men. Evidently, when content is made available that is attractive or fun to women, they will play. It is, therefore, worthwhile to consider what kinds of games can be leveraged for education to promote computer literacy in girls and to attract more girls to technology in general.

BACKGROUND

Social Massively Multiplayer Online Games (MMOGs) as Teaching Tools

Numerous studies have shown that women prefer games that allow for collaboration (rather than competition), complex social interaction and relationships between characters (Gorriz et al., 2000). MMOGs are immersive, three-dimensional (3D) virtual environments (or *virtual worlds*) rich in collaboration and fascinating social interactions between thousands of real people within the worlds (Woodcock, 2005). MMOGs have exploded in popularity in recent years, with more than 5 million players, appealing to both males and females alike. Even popular quest-oriented MMOGs, such as *World of Warcraft* and *EverQuest 2,* which incorporate traditionally male-preferred features such as combat and fighting, still attract a large number of female players due to their in-game social elements.

Of particular interest to us is Makena Technologies' social MMOG entitled *There*, a virtual world similar to *Sims Online* and Linden Labs' *Second Life.* These are not like traditional games with a predefined goal and victory/failure end state. For instance, there is no way to win, lose or die in these worlds; the primary focus is the community and social interactions between the thousands of real people wandering around the world. Players create their own digital avatars, or digital representations of themselves with customizable clothing, hairstyles, facial and body features, and so forth. Characters simply have fun and mingle in various scenic locations; purchase clothing, vehicles or other objects; and interact with digital representations of themselves.

Boys and girls' interest in these virtual worlds can be leveraged for education. In recent years, the pedagogical value of computer and video games has begun to be recognized. Prensky (2003) argues that an engaged, motivated learner cannot be stopped, and that valuable skills such as ill-defined problem solving, learning by doing and other leadership skills can be learned in games that cannot be learned elsewhere. For example, *America's Army: Operations,* a training simulation game, has been very successful in recruiting people into the armed forces (Zyda, Mayberry, Wardynski, Shilling, & Davis, 2003). MMOGs, therefore, seem useful as both a vehicle for delivering educational content and also for promoting computer literacy among both young girls and boys in a fun, active manner.

We set out to determine how effective MMOGs would be in a high school classroom setting in exploring gender and diversity issues related to technology. It made sense to explore these issues due to the experiential, immersive nature of these virtual worlds that enable students to take on the form of someone completely different than them. In particular, we were interested in (1) what can digital experiences within virtual worlds teach high school students about gender issues, stereotypes, diversity and IT; (2) what high school students believe about gender and IT; and (3) why women tend not to play video games or pursue careers in IT.

USING VIRTUAL WORLDS TO EXPLORE GENDER AND IT

To probe these issues, we developed and taught a 5-week course, *ITP Quest: An Exploration of Virtual Worlds and Culture,* as part of a full-scholarship, residential summer-enrichment program that gives the most gifted and talented high school students across the state of Pennsylvania a comprehensive experience in the information sciences and technology. Fifty students were chosen from a large pool of applicants, and our class consisted of 14 students (11 males and 3 females).

The acronym ITP in *ITP Quest* stands for the basic principles *information*, *technology*, and *people*. We emphasized the importance of considering the social factors involved with information technology (IT), including how people interact with information and technology, respectively, and how people are different in various dimensions, which can often lead to differences in technology use or needs. To help the students understand this, the course featured various activities to help students learn about different aspects of diversity (e.g., gender, ethnicity, age, socio-economic status, military experience, etc.), the different ways people use technology and how technology can be used to support communication and learning across cultures. Perhaps most significant of these activities were the interactions within virtual worlds; students were instructed to interact within these digital worlds and to meet all kinds of players from around the world in order to study the integration of information, technology and different kinds of people.

Novel learning was afforded because virtual worlds enabled the students to experience life in the shoes of someone different from them. For example, by designing an avatar to be the opposite gender, the students got to experience a very different set of social interactions and treatment as they embodied

Figure 1.

the new gender in digital form. Most students found it very fascinating to experience life as the opposite gender; some observations included gaining extra attention, more chat requests and more freebies as a female character. In another activity, students were asked to make their avatar's appearance very strange and unattractive, and to observe how people would interact with the character. Students commented on how real-world phenomena, such as discrimination, stereotypes and social status, also transfer into the virtual domain, even though things such as wealth, digital possessions and digital appearance are all not "real":

I designed my avatar to be very unattractive, and as I would walk up to groups of people, they would all scatter and avoid talking to me. Even though stuff like digital money and appearance isn't real, it still affects the way people respect you and interact with you in the game." [Bill]

We found comments like these interesting and helpful in assessing how useful virtual worlds are in stimulating discussion and learning. We also wanted to glean the high school students' insights and opinions on gender differences and technology use, and so we frequently asked them to write out their thoughts on a publicly accessible weblog to help them reflect on their opinions. We then discussed the issues together in the form of an interactive focus group-style discussion. As expected, the students' weblogs and the transcripts of the discussion were very illuminating; the students revealed commonly held assumptions and stereotypes, in addition to insights on why women diverge away from IT in high school, college and beyond.

STUDENTS' THOUGHTS ON GENDER, GAMING AND IT CAREERS

The 14 high school students were asked to write a few paragraphs in their weblogs based on the following question: *Do you think women use technology (e.g., video games, virtual worlds, instant messenger, etc.) differently than men?*

Most of the students felt as though there were clear differences between men and women. The students described men as "more competitive," "more patient with gaming," "more interested in the process of creation and building things" and "needing the fantasy element and being able to do something you can't do in real life such as building a city from the ground up or customizing roller coasters." In contrast, women were described as "turned off by violence," "less patient with gaming," "wanting more choices," "more interested in people and relationships and realism," "more interested in communication and human interaction" and "more interested in designing, organizing and other activities that deal with conceptual form."

Six of the students felt as though women play games much less than men, and these students also observe differences in technology use. For example, one female student, Leslie, described women's use of technology as vastly different compared to men:

I think women use it primarily for communication and gathering information, while men tend to use technology for entertainment. Men have LAN parties, play Unreal Tournament 2k4, which includes running around and fragging people into flaming chunks with a rocket launcher; meanwhile, girls hang out in our rooms and look at Webshots [photo albums], chat on AIM and have Disney movie parties. [Leslie]

When asked about why women are underrepresented in the IT field, most of the students wrote about stereotypes of IT as a "male-dominated field" or a "nerdy guy thing." One student, Janice, felt that "with women who are into computer programming, there's a stereotype that you can't be feminine while doing it." She spoke about her friend Daphne, a cheerleader, and how she was surprised to learn that she is a very skilled programmer.

Most of the class agreed that stereotypes are often unintentionally adopted and begin at a very early age. "When kids are very little," Courtney said, "You wouldn't give a little boy Barbies to play with, just as you don't give little girls a *Final Fantasy* video game. You don't consciously give a girl a video game; I've never received that as a gift."

Other students identified societal prejudices and discrimination or lack of support and resource allocation. Courtney, who attends an all-girl high school, pointed out the differences in opportunities between her school and the all-boys school 5 minutes away:

It's kinda funny, we're about the same size, but there's one class you can take senior year that's actually with computers. But at the all-boys school, they have programming classes, a robotics team, all this stuff, and our school doesn't have any of that stuff. [Courtney]

One student discussed possible innate biological differences as a possibility of why girls don't enter IT-related careers, while another student found this possibility ludicrous:

Personally, I think that's ridiculous. Women and men are different, no doubt, and they are different biologically, but a hundred years ago, people were saying that women were biologically fit to only have kids and stay at home. That's obviously not true, as can be seen now, and hopefully we don't have to wait a hundred years before women are just as accepted in IT, but the world takes its own sweet time. [Janice]

FUTURE TRENDS

When asked about the future of women in IT careers, a few students adopted an optimistic outlook—that it would only be a matter of time for women to "catch up … and [become] completely accepted as they now more are in the fields of medicine and law." Jason, 17, said: "Because women have just been starting to make a huge impact in the IT field, people have yet to realize just how important they will eventually become. It's just a matter of time before women will become just as noticed as men."

Despite optimism for the future, many absent voices still remain in IT, and seemingly this can only exacerbate the problem of stereotyping and designing technology that continues to exclude or alienate women. One concern, for example, is the major shortage of women who work in the gaming industry. Estimates of women who work as game designers, producers or programmers are far less than 10% (Hafner, 2004). Perhaps as awareness of these absent voices increases, appropriate steps can be taken to give women a greater voice in the design of games (and technology).

We agree with a number of researchers (e.g., Rosas, Nussbaum, Cumsille, Marianov, Correa, Flores, Grau, Lagos, López, López, Rodriguez, & Salinas, 2003; Gee, 2003; Prensky, 2001; etc.) who feel that video games can be very useful for educating both boys and girls. In particular, we found games with social interaction (e.g., virtual worlds) as a useful vehicle to teach aspects of IT and social phenomena related to using it. As Squire (2002) observes, more researchers have begun to call for more rigorous research involving video games and education. Some schools have already moved away from traditional textbook and overhead projector-based learning and have adopted more interactive, social constructivist or problem-based learning methods. As this trend increases, so will the need to further study the utility and application of video games, collaborative virtual environments and virtual worlds for education.

CONCLUSION

In our class, the well-thought out weblog responses led us to believe that virtual worlds provided a valuable experience for our high school students that helped them understand the social shaping of technology. The students came to understand that the decisions of game designers ultimately determine who plays in virtual worlds and how the technology of virtual worlds itself affords and constrains communication. Interactions within the virtual worlds revealed social phenomena that gave the students a better understanding of gender and stereotypes. A few of the students felt virtual worlds served somewhat as an *equalizer*:

In a virtual world, everyone is a little more equal, so conversations that might be hindered by cultural differences are considerably more fluid. In a virtual world, it is very easy to find people with similar interests to you. [Scott]

Interacting in a virtual world is not so much a lesson in diversity as an equalizer. As a virtual person, you can create all of your attributes and even your personality to some extent. It may be helpful in diversity education, if a person is honest, because it bridges the space gap between people. [Courtney]

In addition to its perceived value as an "equalizer," we received overwhelmingly positive feedback from the students about using virtual worlds as a teaching tool, particularly in its ability to teach aspects of culture and technology. For example, Max reasoned:

Culture is all about daily experience … an immersive world is all about interacting with others, so it is a perfect means to learn about diversity. Better than simply trying to explain how other people are different, it is easier to learn from the people themselves. Virtual worlds are ideal for that. [Max]

It should be noted that virtual worlds have their limitations. For example, it can be difficult and time consuming to tailor content within the environment to specific teaching goals. Still, we found them very useful as a teaching tool that enabled the students to experience diversity, stereotypes and life as someone different from themselves. Greater awareness helps, but is only one small step in lessening stereotypes associated with IT. Many questions remain unanswered and several challenges lay ahead for women in computing and technology careers, but as young students gain a better understanding of why these questions and challenges exist, they stand more prepared to know the truth from the stereotypes, and more prepared to make informed choices.

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KEY TERMS

America's Army: Operations: A multiplayer online computer game developed by the United States Army for the purposes of training and recruitment.

Avatar: A digital representation of a player in a shared virtual reality.

Massively Multiplayer Online Game (MMOG): Immersive, 3D virtual environments (or *virtual worlds)* with thousands of real players worldwide participating in the game. Examples of MMOGs include *World of Warcraft*, *EverQuest 2, The Sims Online* and so forth.

Problem-Based Learning (PBL): An instructional method that asks students to work cooperatively in groups to seek solutions to real-world problems. It is intended to prepare students to think critically and analytically, and to find and use appropriate learning resources.

Second Life: A highly imaginative, creative virtual environment developed by Linden Labs.

Sims Online: This virtual environment, a networked, socially oriented version of The Sims PC Game, was launched in 2002 by Electronic Arts.

There: A social virtual environment featuring several exotic virtual locales for visitors to explore.

Virtual World: A digital environment, typically networked and multiplayer. See *MMOG*.

World of Warcraft: A quest-oriented MMOG created by Blizzard Entertainment.

Gender, IT, and Educational Choice in East and West Europe

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INTRODUCTION

This article aims to examine the development of aspects of research on gender and IT by means of considering the mainly psychological research carried out by the authors in Europe. Some issues of continuity or change are considered. Broadly speaking, the point of view is taken that gender neutrality in the field of computing and IT would be a desirable goal. However, it is recognized that this point of view is not without its problems. The discussion below about the old communist system in East Europe illustrates this. Nevertheless, the orientation taken is closest to a liberal view of equality. Adam, Howcroft, and Richardson (2004) offer a useful recent account of some of the twists and turns of the debate about the goal of gender neutrality.

BACKGROUND

It can be argued that the literature on gender and IT goes back to the 1980s (e.g., Durndell, Siann, MacLeod, & Glissov, 1988). In that decade an increased interest in issues of gender in society came together with the growing use of computers. During that period, while official figures show that university enrollments in the UK grew considerably, the proportion of undergraduates who were female grew dramatically, from only 31% in 1971 to 48% in 1994 (U.C.C.A., 1971; U.C.A.S., 1995). At the same time it appeared that subject choices were still remaining highly gendered, leading to a traditional pattern of "gender appropriate" career paths. U.C.A.S. figures showed that in the UK in 1995, female university admissions to engineering, computer studies, and the physical sciences were still all below 19% of total admissions to each subject (U.C.A.S., 1995).

The persistence of gender stereotyping within schools had been researched (e.g., Kelly, 1989). Boys tended to prefer physical science, computing, and technology subjects, while girls tended to prefer languages, social studies, biological science, and humanities. A number of explanations had been proposed for this, including obviously the sex-stereotyping of science and technology. If the "hidden curriculum" within schools actively reinforced gender stereotypes, then peer pressure may have been towards taking subjects which were perceived to be gender appropriate. Research at the time showed that both school pupils and University students in the UK continued to regard some subjects, including engineering, computing and the physical sciences as masculine, and others including English, French, biology, psychology, and sociology, as feminine (Archer & Freedman, 1989). The female attraction to biological sciences was shown by their success in entering competitive professions like veterinary science and medicine, which were previously male-dominated and had stringent science entry requirements.

A study carried out in Scottish schools (Lightbody, Siann, Tait, & Walsh, 1996) sought to investigate pupils' experiences when choosing which subjects to study at ages 15 and 16-17. During group discussions the school pupils firmly rejected the notion that some jobs were better suited to males or to females. The responses from the girls were unequivocal—*anyone can do anything*! Nevertheless, when asked about their own choice of course or career, pupils' responses fell into a stereotypical gender pattern—girls tending to wish to enter careers in the arts and caring professions whereas the boys were more likely to choose a technological area.

Lightbody and Durndell (1998) asked first-year university students why they chose the course on which they were enrolled. Results indicated that the reported reasons why women favoured law and medicine, rather than more technological courses including computing, were that the former courses were seen to be leading to work that contributed to playing a useful social role and that would allow a higher level of social contact. It was concluded that although women tended to avoid technological courses this was not necessarily a negative choice, rather they *positively chose* courses perceived to lead to careers with higher levels of social involvement.

An idea current at the time was that while girls may lack confidence in their own ability to work with computers, they do not believe that this inability generalises to females as a whole: "*We can, I can't*"—that is, we (females in general) can, but I (personally) can't. Lightbody and Durndell (1998) argued that a better way to phrase this might be "*We can, I don't want to*"—that is it was a lack of desire rather than lack of confidence which prevented girls from entering technological careers.

Some female school leavers avoidance of careers in physical science and technology may not be initiated at a conscious level. Bem (1993) proposed that hidden beliefs about sex and gender roles, which she labelled "lenses of gender", are so deeply entrenched in society that they are no longer visible, but that their pervasive qualities nevertheless permeate our entire culture.

Durndell and Thomson (1997), in an article entitled Gender and Computing: A decade of change?, reported on a series of UK studies of groups of natural science and business studies students on entry to university. They were asked questions about their reported use of computers, knowledge about IT (information technology) and reasons for their choice of subject at University. Data was collected between 1986 and 1995 in a cross sectional design. This decade was a period of enormous change and advances in the world of computing, with the level of hardware and software available increasing almost beyond the dreams of many of the users at the beginning of the decade.

Reported use of computers in school by recent school leavers showed a general increase from 48% to 93% over time, becoming very high, with no gender differentiation, reflecting the widespread introduction of computers into schools. Reported use of a friend's computer, which could be a measure of the extent to which teenagers used computing as a social activity, showed little evidence of change over time. However, it always showed a gender difference with the activity being reported more by males—65% males to 46% females in 1986, and 66% males to 43% females in 1995. Reported use of ones own computer increased considerably over time, and the large difference with males reporting more use of their own computer than females was maintained; from 24% of males to 9% of females in 1986, to 59% to 31% in 1995.

A test of IT knowledge was also taken over time, and showed, not surprisingly, that the level of knowledge was continuously increasing. The gender effect was particularly interesting. In spite of the fact that these male and female students had similar levels of qualifications, the males consistently and considerably outstripped the females in their average level of knowledge. The absolute size of this difference was consistently declining over the period but the rate of decline was so slow that an equalisation of performance seemed a long way off.

Durndell and Thomson also found that the reasons given for choosing not to study computing remained relatively consistent over time, and remained very little gender differentiated. The responses gave the impression that there was a strong stereotype of the computer specialist as someone who interacts far more with machines than people.

Durndell and Thomson concluded that it seemed reasonable to argue that in the UK the previous decade had produced some slight change in the relative interest and involvement with computing of females as opposed to males, but that this change had been very limited. Gender equality, in the sense of having no difference between males and females in attitudes towards, knowledge about and use of computers appeared to be along way off. Durndell and Thomson (1997) speculated that it might not happen within the lifetime of the readers of the article.

A GENDER NEUTRAL ENVIRONMENT?

While interest and research on gender and computing was developing in the 1980s and 1990s, some remarkable changes were going on in Europe. The split between west Europe and the communist regimes of central and east Europe was coming under pressure, resulting in the collapse and transformation of most of the communist states by the early 1990s. This was of considerable interest to anyone studying gender in relation to science and computing, as the communist states proclaimed that equality had been achieved and that any problem of equal access to science for males and females was solved (Durndell, Uzunova, Asenova, Asenov, & Thomson, 1998). Critiques of these societies did argue that much of this was a sham, and there was discussion about women's double burden (Buckley, 1989), that is that they were forced to both work at home and in the labour market. Nonetheless, while the communist countries' level of technological development lagged behind that of western Europe, they had a history of producing proportionally far more female technologists, engineers and physicists than western Europe or the United States (Durndell, 1991). These countries were industrialised in the communist era, and as well as emphasising gender equality they also emphasised the role of technology. As late as the 1980s, as many if not more females than males were studying to be engineers in these countries (Durndell, 1991), at a time when under 10% of engineering students were female in the UK. It seemed that the sex role expectations in these countries were somewhat different from those of the western industrialised countries.

However, with the collapse of the regimes, a natural experiment occurred, and the question could be asked as to whether the apparent relatively gender neutral approach to technology would survive or would turn into the Western pattern of relatively greater male dominance of technology. Would relatively gender neutral attitudes towards technology be deeply embedded as the computer age developed, or would they be perceived as features of the now discredited communist society and reacted against? Reinen and Plomp (1997), as part of a large cross cultural study on school children's knowledge about computers and use of computers, found that their Bulgarian sample provided amongst the smallest gender differences of the countries examined. Wright (1997) utilising U.N.E.S.C.O. data in another cross national comparison of a large number of countries, found that the majority of students in maths and computing in Bulgaria and Romania were female, making up more than double the proportion of females that were found on similar courses in the UK. Durndell, Cameron, Knox, Stocks, and Haag, (1997) found that while Romanians had less direct experience of computers than their western counterparts, they were at the same time more positive about computers. However, Durndell, Haag, and Laithwaite (2000) found that the Romanian females were less self confident about their use of computers than males were, thus replicating the Western Europe situation. Finally, Durndell, and Haag (2002) found that Romanian students were producing similar gender differences to those referred to in the "Background" section. Females tended to report less self confidence with computers and more computer anxiety than males, which strengthened the view that these countries were to some extent switching to the western European model.

This last study also started to specifically address Internet use and gender. Gender effects were found here also, with males on average having more favourable attitudes towards the Internet than females and using it for longer times. The point was made that the gender and computing literature may extrapolate to the study of the Internet.

THE INTERNET APPEARS

The rapid growth in the use of the Internet led to the above question being asked quite widely (Gackenbach, 1998). Internet use has developed such that for most people it now represented their main contact with computers. Would this be a gender neutral environment or would the phenomena observed with computer use per se also be seen with the Internet? Gackenbach argued that by the late 1990s, as studies appeared of gender and the Internet, it was looking as though Internet use and attitudes towards the Internet were closely resembling the previous research on computers.

In the literature, *computer anxiety* refers to an affective response. For example, the individual's avoidance of computer technology may be a function of fear, intimidation, hostility, and worries that they will look stupid, be embarrassed, or even damage the equipment. Miller and Durndell (2001) concluded that the amount of computer experience had the clearest relationship to computer anxiety of any variable studied. Gender differences in computer anxiety have often (although not always) been found as females have been shown to be more computer anxious than males (Balka & Smith, 2000). However, as the previous experience of males with computers is greater the findings supporting a correlation between gender and computer anxiety are problematic. It could also be that females have a greater tendency to report anxiety in general.

Many studies in the area of *computer attitudes* have also concentrated on attempts to identify which other variable is the main determinant of attitudes towards computers. Those focussing on gender often found that women and girls are likely to hold more negative attitudes toward computers and to engage in fewer computer-related behaviours than are men and boys (Balka & Smith, 2000). Again, one could argue that gender differences in experience with computers lead to gender differences in computer-related attitudes. These conclusions were supported by Chua, Chen, and Wong (1999) and Coffin and Mackintyre (2000) who carried out meta analyses on this literature.

Given this, is it reasonable to expect that the same issues of gender, anxiety, attitude and use will be salient with regard to the Internet? Generations of children are growing up in many industrialised countries that have been socialised to use computers and the Internet from an early age. In the late 1990s more males than females used the Internet and they tended to access more domains, used it more often than females and for longer periods of time (Kraut, Patterson, Lundmark, Kiesler, Mukopadhyay, & Scherlis, 1998). Schumacher and Morahan-Martin (2001) argued that the computing literature was indeed extrapolating to Internet use. A further feature was the masculine nature of online culture, reflected by the behaviours of "flaming" (uncensored hostility online) and Internet pornography. These elements of male computer culture were threatening to women (Pohl, 1997), and may have led to the anticipation of harassment and offensive language.

One feature of the Internet oriented research is that questionnaires concerning attitudes towards computing or computer anxiety can be altered to study the Internet by replacing the word "computers" by the "Internet" (Durndell & Haag, 2002). For example Miller and Durndell (2001) found significant correlations between a positive score on an attitude towards the Internet measure, a lower score on a computer anxiety measure and higher reported use of the Internet.

FUTURE TRENDS

The increased use of computer or Web based communication is impacting both on our social world and education. Asynchronous computer-mediated communication (CMC) refers to text-based communication that takes place over computer networks in delayed time. This includes electronic mail and online discussion forums such as newsgroups, bulletin boards or asynchronous computer conferences.

It has been claimed that the loss of social context cues, such as gender, in text-based CMC could equalise participation, making it a more democratic, even utopian, form of communication in comparison to traditional face-to-face methods (Sproull & Kiesler, 1986). The loss of nonverbal cues of status and power could enable participants, who might tend to defer to higher-status participants in face-to-face interaction, to become uninhibited and participate more. The contrary view would be that on line communication would follow face to face communication and be subject to the same constraints, (i.e., will mimic any power relations that are found in society at large (Sussman & Tyson, 2000). Work by Thomson and Murachver (2001), for example, supports the latter view.

Miller and Durndell (2004) found that females compared to males were significantly more likely to choose an anonymous number rather than their name to identify themselves online. In addition they also found that males had a tendency to post negative responses to contributions online, whereas females were more likely to respond positively to other participants in the online discussion

It seems that CMC does not necessarily provide a gender free environment, and that the comments of Sussman and Tyson (2000) are appropriate, that power relations in wider society will be reproduced in on line communications.

CONCLUSION

This article has briefly considered aspects of the history of the gender and IT research literature over the last 20 years. It began with the widespread introduction of computers and moved on to the introduction of the Internet and Web-based communication including CMC. Even after looking at a possible example of a gender neutral cultural context, there is no doubt that the literature throughout is imbalanced. Either researchers find no gender variation, or they find variation reflecting male power or interest in technology. It would be wrong to conclude that nothing has changed over this 20-year period. On the other hand, in spite of many schemes to attract women into computing (which are not discussed here), the computing and IT world still seems to be far from being a gender neutral world. This is a serious matter, as Internet use has followed reading and writing in industrialised countries to become ubiquitous. But then reading and writing could be argued to be not gender neutral as well.

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KEY TERMS

Asynchronous CMC: Online communication taking place in delayed time.

Computer Anxiety: Negative emotions about computers.

Computer Attitudes: Thoughts about computers.

Flaming: Hostility expressed online.

Gender Neutral Environment: An environment where males and females are treated equally and achieve equally.

Gender Stereotyping: Portraying characteristics as general to all males or females.

Lenses of Gender: Embedded beliefs pervasive in a society about males and females.

"We Can, I Can't": Phrase referring to a girl's belief that girls in general can be good at computers, but the girl herself is not.

"We Can, I Don't Want to": Phrase referring to a girl's belief that girls in general can be good at computers, but the girl herself is not interested.

Gender, Place, and Information Technology

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INTRODUCTION

The individual sense of gendered identity and location are embedded within information technology (IT) usage (Meyrowitz, 1985). Exploring gender in relation to place and IT assists to reveal the impact that cultural knowledge has upon IT usage. This article illustrates the intertwined complex of issues that associate gender and place with IT by examining the currently dominant approaches to research conducted around this topic. The article begins with a presentation of the founding concepts regarding location and the construction of the gendered self, and then discusses investigations of gender, place and IT usage that utilize geographical and bounded constructs and, alternatively the concept of socially occupied space.

BACKGROUND

Situating experience physically—and by implication, locationally—reveals how socio-cultural and socio-technical knowledges play a significant role in the shaping of human action. Maintaining a sensitivity to sociality within IT-oriented research prevents solely technical considerations being interpreted as primary causal factors. Culturally shared knowledge—including media events, physical location, physical sensation and sexual innuendo—is utilized in all IT-enabled exchanges of information. These exchanges serve to strengthen "group" identity and solidarity. Although computer-mediated presence is not a physical environment, the range of possible experiences that can be achieved through engagement with IT-enabled environments are influenced by existing inequalities in the enveloping physical environment. The continual presence of this surrounding physical environment influences knowledge formation to all activities conducted in the IT-enabled environment. IT usage can locate the user—and their actions—simultaneously at many hundreds of machines, creating a physical indeterminacy of presence that challenges the dualisms of physicality, spatiality and the traditional understandings of gender formation (Green, Owen & Pain, 1994). While gendered examinations of inequality abound (Adam, Howcroft & Richardson, 2002; Wilson, 2004), explorations of the gendered body in relation to technical artifacts are relatively under-represented within IT-based research. By exploring this gap and the intersections of gender, place and technology, it is possible to identify the significance of existing socio-cultural experience and technical knowledge as both barriers and gateways to knowledge acquisition in IT. The conflation of self presence with a "place" makes identity formation a complex phenomenon difficult to isolate or parameterize.

The notion of place and identity are well established in social science disciplines and particularly within geography (Ashkenas, Ulrich, Jick, & Kerr, 1995). "Place" is considered by many (Soja, 1996; Massey, 1994) as primarily a geographic construct providing the individual with a sense of "where" and "when." However, with few exceptions (see Boland (Jnr), 2001), "modern" organizational forms tend to be analyzed and constructed within traditional and, consequently, physically fixed world views. Predominant discussions (e.g., Gagliardi, 1992) relating to an organization's physical form reinforce underlying assumptions regarding IT and gender. These positions limit the scope of current analysis in IT research and in relation to gender as self-legitimating arguments that obfuscate critical perspectives.

IT Artifacts and Human Activity

The argument presented by this article is indicative of a growing body of research (Gagliardi, 1992) that predominantly combine anthropological and geographical approaches to the examination of human activity and IT artifacts within organizations. Most notably among these approaches is the collection by Gagliardi (1992). These studies critically consider the limits imposed by IT usage on employees' success in their day-to-day activities. Arguably, the utility and strength of these studies is the parallel considerations of IT artifacts and organizational culture. As Ciborra et al. in Gagliardi (1992) state, "We submit that most recounts overlook the complex interactions between systems as dynamic artifacts and organizational culture." There is a conscious effort in these works to move away from the causal considerations of computers as tools or control devices towards their role as participatory elements in the organizational environment.

The long history of social constructionist research has tended to look beyond physical form as the primary determinant in the examination of humans and technology. Notions of gender, place, space and even time are seen as social constructs that shape human perspectives of location, boundary and border.

The inclusion of daily lived experience and, specifically, gendered experiences, into the consideration of IT is a significant departure from technologically focused theories associated with implementation and organizational considerations (Ashkenas et al., 1995). Acknowledgement of the significance of cultural roles and everyday life enables an alternative interpretation of the spatiality that is embedded in IT. Geographically focused approaches that consider gender and IT usage, in contrast, utilize physical and observable boundaries (Johnston, 1997), including the spatial limitations imposed by a location. The neglect in explicitly articulating the gendered self of the researcher and the subjects of their research also consequently ignores the socio-cultural aspects of spatial constructions. Examining "place" in relation to the gendered body associates a series of physically bound artifacts, including computers and their intricate ongoing relationship with humans.

Sense of Place

Massey (1994, p. 119) describes "place" as a gendered experience that allows individuals to experience "locality" and "inhabitance" along with their own feelings of self-awareness:

So the search after the 'real' meanings the 'self' in relation to 'place,' is the unearthing of heritages and so forth, which is interpreted as being, in part, a response to desired fixity and for security of identity in the middle of all the movement and change. Obtaining a 'sense of place', of rootedness, can provide—in this form and on its interpretation—stability and a source of unproblematical identity.

"Unproblematical identity," which encompasses gender-inclusive identity, is pivotal to the successful inhabitance of IT-enabled places. Inhabitance can be described as the willingness that people have to visit and continue to revisit a space, including IT-enabled environments. This willingness is reflected in the familiarity and closeness that people access and use IT. Anzaldua (1987) offers an example of how familiarity and descriptive closeness can influence relationship and identity formation in relation to "place." Anzaldua extends her observations of marginalized gendered experiences, providing insight into the intimacy through which she experiences place.

I am a border woman, I grew up between two cultures, the Mexican (with heavy Indian influence) and the Anglo (as a member of a colonized people in our own territory). I have been straddling that Texas-Mexican border, and others all my life. It's not comfortable territory to live in, this place of contradictions. Hatred, anger and exploitation are the predominant features of this landscape.

However, there have been compensations for this mestiza [a woman of mixed racial ancestry], and certain joys. Living on borders and in margins, keeping intact one's shifting and multiple identity and integrity, is like trying to swim in a new element, an 'alien' element ... [that] has become familiar—never comfortable, not with societies clamour to uphold the old, to rejoin the flock, to go with the herd. No, not comfortable but home. (Anzaldua, 1987, preface)

Massey (1994, p.151) explains that a sense of "place" is established when individuals are able to achieve the combined sense of "locality" and "inhabitance." The "feeling" of place is achieved through stable identity formation, including and acknowledging one's gendered identity. In the context of IT-enabled environments, this "feeling" includes identification and familiarity of the IT artifacts being utilized.

Organizations as Bounded Territories and Places

Another way of examining the gendered experience of IT usage within an organization is to employ a spatial perspective. The construction of the organization as a territory, dichotomized between the bounded and unbounded, draws again upon geographic theories as a reference point. Ashkenas et al. (1995) utilize this perspective for their examination of IT. In their example, Ashkenas et al. (1995) emphasize geography in the hierarchical organization that is explored and challenged. The underlying concern in their work is the spatial examination of organizational structure. Spatial understandings of IT simultaneously depict ideas of vastness as well as emptiness. The spatial relativity of objects, such as water and our bodies, are often depicted as extensions of a surface (see Grosz, 1995; Bordo, 1996). The implication implicit in this representation is that extending the surface also incorporates notions of depth and vastness. This understanding of space is also regularly drawn upon to describe and situate human bodies, and therefore, contributes to social constructions of the gendered body (see Grosz, 1995; Bordo, 1996). Density is an aspect of spatial form and is expressed in the popular descriptions of outer space or the depths of oceans. However, spatial notions of depth also incorporate the idea of an inner space. Space conventionally encapsulates a dichotomized position that incorporates the void of an object. Lefebvre's definition of space is most clearly presented by Molotch (1993).

Space is not simply inherited from nature, or passed on by the dead hand of the past, or autonomously determined by 'laws' of spatial geometry as per conventional location theory. Space is produced and reproduced through human intentions, even if unanticipated consequences also develop, and even as space constrains and influences those producing it.

Lefebrve's understanding of space emphasizes the human requirements for constructing spatial forms. He does this by privileging the subjectivity inherent in the construction of social reality over the object-filled approaches utilized by other spatial analysis and, most particularly, those engaged in studies of geography. These studies are based on Cartesian theory; in other words, the mathematical rules of geometry that extrapolate the socio/temporal relationships of the universe into a manner capable of formulaic manipulation (Woods, 1996). It is Cartesian theory that provides an axis for understanding our "reality" through the duality of time and space. Within this dichotomy, it is time more than space and its impact on work practices, and hence, IT usage that has been, and continues to be, studied (see Boland (Jnr), 2001).

FUTURE TRENDS

Exploring the interaction between humans as gendered beings and objects requires a discussion of "spatiality" and the differing spatial configurations a variety of theorists have presented. "Spatiality" has an association with both time and space. A bodily object is understood in terms of it existence, its connection to "reality" and its mathematical representation (Lefebvre, 1991). The way we spatially position objects in our day-to-day lives is conventionally understood in terms of a human focal point and the relationship between objects and humans. These perspectives are tied closely to Western traditions of Humanism and the absence of the Cartesian object (Jones, 1993). Reality is constructed through existing observable material structures, those "things" that dominate the spaces of daily life. Structures, such as buildings, furniture and other people, can be critically presented as meaning-stabilizing entities (Rosen, Orlikowski, & Schmahmann, 1992). The existence of objects—in "reality"—requires a human physical presence to define its social meaning. When the individual is separated from the social system, it reinforces constructs that assert the presence of an ego "within," or "inside," the individual, while society remains "outside" (Elias, 1978). In constrained spatial analysis, such as that of Elias, social systems occupy a boundless space outside the individual and are disjointed from the bounded space defined by the traditionally understood gendered body. A spatial description such as Elias' is static, placing time and all other social constructs in an arbitrary conceptual opposition to space (Laclau in Massey, 1994). Giddens (1985) as a structuration theorist, and in contrast to Elias' ideas, interlocks the notions of time and space and, more specifically, time-space compression to interpret the contemporary usage of IT. Utilizing Massey's theories regarding "place and gender" with spatial theory such as Lefebrve's allows an analytical shift away from structural and notional time constraints. This shift from the theoretical emphasis found in works such as those of Elias and Giddens is necessary if the conducting of research is to be a determinant of meaning. As Lefebvre (1991) and other spatial theorists argue, it is socially occupied space that can most appropriately be utilized to explore all components of human interaction. In this way, it is arguably one approach that can be drawn upon when interpreting IT usage in a gendered context.

CONCLUSION

Lefebrve (1991, p.38) defines place as:

... the relationship of local to global; the representation of that relationship; actions and signs; the trivialized spaces of everyday life; and, in opposition to these last, spaces made special by symbolic means as desirable or undesirable, benevolent or malevolent, sanctioned or forbidden to particular groups. We are not concerned here with mental or literary "places," nor with philosophical topoi *[conventions], but with places of a purely political and social kind.*

Space in this configuration is the "place" that the individual goes to or chooses not to go to. As an embedded aspect of Western consciousness, space encapsulates all the tensions and oppositions that enable and restrict the individual and the group to interact and conduct their daily lives. Accounting for the gendered place of socially occupied space involves the description of not only the mundane daily visits to the stationary cupboard and canteen but also the quick peek into a fellow worker's desk drawer to identify those objects associated with gendered identity. Documentary films, ethnographic accounts and the narration of daily activities provide the media for presenting the configurations of place, gender and identity. An understanding of the gritty reality of life and all the limitations and possibilities that unravel in daily life are necessarily presented to the reader once the analysis of a user's place in relation to IT has been carried out. An example of this theoretical application exists in works, such as Hooper's (1992) work exploring the production of citizen-bodies in classical Athens, nineteenth-century Paris and Los Angeles through a critical reading of the political emanations from the body of citizen Rodney King. Hooper (1992, p. 50) acts to place disorder at the borderlands of bodies, cities and texts. For example, she writes that:

Body and the body politic, body and social body, body and city, body and citizen-body, are ultimately linked productions ...

The practice of using the individual body as metaphor for the social body, of deploying it as a sign of the health or disease of the social body, develops in the Athenian polis with ideas of the democracy and reason, and continues into the present. Body and city are persistent subjects of a social/civic discourse, of elements and an equally obsessive desire to bring them under control: fear of pollution, contagions, disease, things out of place; desires for controlling and mastering that [become] the spatial practice of enclosing unruly elements within carefully guarded spaces.

The research exploring place, gender and IT echoes Hooper's (1992) sentiments, as it extends Lefebvre and Massey's notion of place, gender and identity construction theoretically. "Place" is an avenue from which to explore gender and IT, which, in turn, enables the unraveling of the significance of culture and knowledge acquisition in IT usage. By situating experiences both locationally and, therefore, physically, we are able to show that socio-cultural and socio-technical knowledge play a significant role in shaping the actions of participants. The acknowledgement of "gendered place" in identity formation and IT usage enables sensitivity to sociality not to be subsumed by technical considerations. Considerations of artifacts as they relate to daily experience and identity formation enables an understanding of knowledge acquisition that is IT enabled. The significance of culturally shared knowledge, including gender, physical location and physical sensation, are often neglected when studying users of IT and how they exchange information. Although IT existence is not necessarily tied directly to any physical environment, the range of possible experiences that can be undertaken when engaging with IT are influenced by existing inequalities in the physical that consequently affect knowledge formation via IT.

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KEY TERMS

Gendered Body: Recognition that the physical human body is itself a product of cultural and social forces.

Gendered Place Experience: The combined experience of "locality" and "inhabitance" framed within an individual's own sense of self awareness.

Knowledge: Understanding that is actively constructed by the learner; not passively received from the environment.

Inhabitance: The willingness of individuals to visit and continue to revisit a space, including IT-enabled environments.

Place: Primarily a geographical construct providing the individual with context for the temporal and spatial concepts of "where" and "when."

Socio-Cultural Knowledge: Experiential understanding of the external social world and its forces.

Spatiality: The way in which an object is understood in terms of it existence, its connection to "reality" and its mathematical representations.

Gender, Race, Social Class, and Information Technology

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INTRODUCTION

The issue of the underrepresentation of women in the information technology (IT) workforce has been the subject of a number of studies, and the gender gap was an issue when the digital divide dominated discourse about women's and minority groups' use of the Internet. However, a broader view is needed. That perspective would include the relation of women and IT in the communities in which they live as well as the larger society. The information society that has emerged includes the United States (U.S.) and the globalized economy of which it is an integral part.

Women and minorities, such as African Americans and Latinos, are underrepresented in computer science (CS) and other IT positions in the U.S. In addition, while they are no longer numerically underrepresented in access to computers and the Internet, as of 2000 (Gorski, 2001), they continue to enjoy fewer benefits available through the medium than white boys and men. The following article explores the diversity within women from the perspectives of race, ethnicity and social class in North America, mainly the U.S.

The technology gender and racial gap persists in education and in the IT workforce. A broader and deeper look at women's positions in relation to the increasingly techno-centric society reveals that women may have reached equality in access, but not in academic study and job opportunities.

BACKGROUND

Linebarger (2003) pointed out three traditional digital divide constructs: "family socioeconomic status," "location of access to new technologies" and "gender/race" for school-age children. Inequities tend to appear along both social class and gender lines, with male students and students from high socioeconomic status backgrounds well positioned to outpace female students and students from lower socioeconomic backgrounds in terms of computer skills and knowledge (Lockard, Abrams, & Many, 1987).

Equality in Access, but No Equity in IT Jobs

The gender digital divide refers to the gap in access rates between men and women (Gorsky, 2001). Based on this traditional gender digital divide definition, the gender digital divide gap has narrowed to reach "access equality." In 2002, 83% of American family households owned a computer (Corporation for Public Broadcasting, 2004). About the same proportion of adult men and women had access to home computers. The digital connectedness of American families was increased through home computer ownership. In 2001, 59% of American people had connections at home. By the end of 2000, women surpassed men to become a majority of the U.S. online population (Gorski, 2001).

The societal race and gender gaps in the U.S. as a whole have narrowed in the past 10 years, but in the IT field, the gender gap generally appears to be wider at all levels of employment. Overall growth in these IT occupations was so strong during the decade of the 1990s that women working in IT continued to increase through the year 1996. According to D'Agostino (2003), in 1996, women occupied 41% of jobs in the IT field. The ITAA (2003) recorded a decline to 34.9% by 2002.

The situation is worse in highly professional positions, such as computer programmers and com-

Table1. Representation of women in various IT jobs in 2002

Information Technology Occupations	% Men	% Women
Computer systems analysis and scientists	72.2 %	27.8 %
Operations and systems researchers and analysts	51.3 %	48.7 %
Computer programmers	74.4 %	25.6 %
Computer operators	53.2 %	46.8 %
Data entry keyers	18.3 %	81.8 %
Total IT occupations	65 %	35 %

puter systems analysts, where women tend to lag far behind men. Table 1 shows how women are over represented in lower IT positions, while there are few women in professional CS fields.

However, the potential exists for this situation to change. Kvasny (2003) reports that minority women in low-income communities perceive IT as a means of escaping poverty, while highly educated, middle-class and professional women regard IT as offering fewer opportunities for advancement. Kvasny suggests that IT and gender studies recognize the diversity within women.

Gains in Access, but Loss in CS Major

The problem of underrepresentation of women in IT starts from the math and science pipeline at school. Through high school, girls are less likely than boys to enroll in CS classes, and the disparity increases in programming courses.

The American Association of University Women (AAUW) commissioned early studies on the gender gap in education (1992, 1998). The first study noted the barriers faced by children from lower socioeconomic status. It also pointed out that African American girls had fewer interactions with teachers, even though they tried to initiate such interactions. By the latter AAUW study, the issue of technology had emerged. The report noted that a gender gap had begun to appear in CS classes. Girls made up only a small proportion of students in such classes, and the gap widened between grades eight and eleven. The study reported that boys exhibited a higher degree of self-confidence about computer skills than girls.

According to the National Council for Research on Women (2002), by the eighth grade, Latinas score higher in math than their male peers; and by 12th grade they do better in science than Latinos, but they are outperformed by their male peers on the math SATs.

A more alarming situation is the trend of fewer women entering the field of CS. Between 1985 and 2002, women went from earning 36% of the CS bachelor's degrees (D'Agostino, 2003) to only 20% in 2002 (Taulbee, 2004). Even when women choose CS as their major, their relative (compared to men) lack of preparation for the coursework and male-dominated classroom climate forces them to drop out of the program (Margolis, 2003).

Table 3 shows the distribution of bachelor's degrees in CS by the race/ethnicity of the recipients for 2001. Analysis of the figures from a gender perspective reveals some interesting patterns. One is that the gender gap is greater among white women than women from underrepresented minorities. Generally, African American and Native American women and Latinas earn more than their share of science and bachelor's degrees than men in their respective groups (National Council on Research for Women, 2002).

White women earned 22% of the CS bachelor's degrees conferred on white males and females, while underrepresented minority women earned 41%

Table 2. Computer science degrees by gender

	Bachelor's	Master's	PhDs
Male	80.6%	73.6%	83.2%
Female	19.4%	26.4%	16.8%

Table 3. Bachelor's degrees in computer science degrees by race/ethnicity and sex of recipients 2001

Race/Ethnicity	Male	Female
White, non-Hispanic	18,479 (78%)	5,296 (22%)
Under represented Minorities	3,892 (59%)	2,663 (41%)
Black, non-Hispanic	2,182 (53%)	1,906 (47%)
Hispanic	1,519 (69%)	680 (31%)
American Indian or Alaskan Native	191 (71%)	77 (29%)
U.S. Citizens and Permanent Residents, Unknown Race/Ethnicity	1,492 (73%)	549 (27%)
U.S. Citizens and Permanent Residents, Total	28,013 (73%)	10,517 (27%)

Source: Taulbee, 2003

of the CS bachelor's degrees conferred on minority males and females. Among African American CS bachelor's degree recipients, the numerical gap is almost non-existent, less than 300 out of a total of just less than 4,100. The gap between Latino/Hispanic males and female bachelor's recipients is much larger than that among African Americans, 839 out of 2,199. The picture is similar for American Indian CS bachelor's recipients, with a 29% female to 71% male ratio.

Why don't girls' recent gains in access to technology translate into long-term advancement in college majors and careers? Gurer and Camp (2002) noted that attitudes, computer experience, computer games, mentoring and role models, self-confidence, computing environments, societal influence, teacher and family encouragement, all-female environments, and perceived difficulties in balancing work and family are some factors contributing to the problem. The "nerd" image of the field, the fact that computer games are targeted mostly at boys, the perception of computing careers as boring and the lack of role models for girls are a few reasons pointed out by Margolis and Fisher (2000).

Cohoon (2001) points out that despite beliefs espoused by some in CS that women have deeply ingrained traits that suit them less for study and practice of CS than men, female underrepresentation in CS could be avoided. Gilbert has observed the importance of support systems for immigrant groups studying CS and suggested that underrepresented groups in the U.S. could benefit from such practices (Loftus, 2004).

TECHNOLOGY ACCESS AND SOCIAL CLASS/SOCIOECONOMIC STATUS (SES)

Here, technology access will be discussed from two perspectives: computer access and Internet access. Table 4 shows computer usage by 5-17 year olds, either at home or at school, by their parents' education and by income (NCES, 2003). A large gap exists between children whose parents have the least and the most education. Rates of students using computers at school are fairly even among students from high-income families and from low-income families, 75.2% and 85.4%, respectively. Schools have played a key role in access equality for students of different backgrounds.

Table 4. Computer usage, ages 5-17, 2001

		Home	School
Income	average	65%	81%
	>$75,000	89%	85%
	<$20,000	31%	72%
Parents' education	Didn't finish high school	26%	Not available
	Has post graduate degree	90%	Not available

Source: NCES, 2003

According to the National Center for Education Statistics (NCES, 2001), in 1994, 20% of public schools in low-income areas enjoyed Internet access, while 35% of all public schools had such access. By 2000, the figures were 94% and 98%, respectively.

Of those who use the Internet, 78% access it from home, compared to 68% from school. Thirty-five percent of students from families with income of less than $20,000 access the Internet at home, while 52% do so at school (NCES, 2001). Again, schools have played an important role in narrowing the digital divide by providing equal access to students from different class backgrounds.

When girls are compared to boys in terms of computer access, Internet access, time spent on computers, and Internet and computer activities, they are not much different (National School Boards Foundation, 2000). In fact, Linebarger and Chernin (2003) show that among children between 4 and 8 years old, boys use computers more than girls, but use Internet less than girls do.

What affects girls the most with respect to the digital divide is their SES, similar to the case for boys. There is research on correlations between gender and social class or SES and computer access. Davies, Hancock and Condon (2003) reported that there is little difference in access to home computers and access among families with high SES for boys and girls, but there is about a 10% difference in home computer and Internet access between boys and girls in lower SES families.

Usage of home computers varies by social class or SES. Fifty percent of the children from high-SES families with home computers used word processing, compared with only 24% of the children from low SES families with computers at home (NCES, 2001).

Parents' SES influences students' attitudes toward computers and eventually contributes to widen the technological gender gap. Shashaani (1994) reported that family SES affected sex differences in attitudes towards computers. In general, gender-differential attitudes are more pronounced in the lower socioeconomic group, and SES has a stronger effect on girls than boys. Both girls and boys perceive the gender stereotypes about computing held by their parents, and such attitudes inversely affect girls' own attitudes.

FUTURE TRENDS

From a societal perspective, while girls' and women's use of computers is on par with use by boys, it is yet to be seen if the comparable patterns of usage in the future will translate into equitable academic and professional outcomes. The computing environment, starting from the home through elementary, middle and high schools, must be made more encouraging (Cohoon, 2001; Margolis, 2000). Further research on family SES with gender needs to be done. In addition, race and gender interactions have not yet been a central theme among researchers, but research sponsored by the National Science Foundation is altering research priorities. The findings by researchers such as Kvasny (2003), that working-class African American women see opportunities in computer-related or IT careers in contrast to middle-class white women's perceptions of obstacles in the CS pipeline, need to be explored in further research.

CONCLUSION

While school provides good access to all students, and computer access is theoretically equitable between the sexes, complex social factors serve to limit girls' participation both in school and at home. Technology is more than physical resources; it is intertwined with social and cultural factors that differentially affect interactions. These include family computer cultures and encouragement, psychological access, social identities and the setting for the technology use, to name a few.

The traditional definition of "digital divide" no longer paints an accurate portrait of technology. The whole picture needs to be evaluated from a broader perspective. As computer prices continue to fall, lower SES families or schools in low SES areas may have greatly narrowed the traditional digital divide, but further gains may be difficult.

Simple class and economic predictions cannot be made, even within white American segments. The process becomes much more complex as race and ethnic characteristics are included.

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KEY TERMS

Digital Divide: The condition of unequal access to computer-related resources, varying along the demographic dimensions of age, gender, race and ethnicity, education, income and nationality.

Diversity: In a social and cultural context, the presence in a population of a wide variety of cultures, opinions, ethnic groups, socio-economic backgrounds, disabilities and sexual preferences.

Information Technology (IT): A term that encompasses all forms of technology used to create, store, exchange and use information in its various forms. Graduates of computer science majors may seek IT jobs.

Math/Science Pipeline: A phenomenon where the number of female students, students with lower socioeconomic status, and students of color in proportion to white males in advanced math and science progressively declines during high school.

Social Class: A category of people who have generally similar educational histories, job opportunities and social standing and who are conscious of their membership in a social group that is ranked in relation to others and is replicated over generations.

Socioeconomic Status (SES): The economic, social and physical environments in which individuals live and work, as well as demographic and genetic factors. Measures for SES may include: income or income adequacy, education, occupation or employment.

Underrepresentation: A situation in which members of a group by color, race, sex or ethnicity (but not all) constitute a lower percentage of the total number of people within the category in the job market, or in schools.

Gender-Based Attitudes Toward Technology

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INTRODUCTION

During the past 30 years of investigation into the ratios of males and females using technology (Harrison, Rainer, & Hochwarter, 1997), there have been consistent reports of males being more positive toward technology and being more likely to adopt the use of new technology on a voluntary basis (Volman, & Van-Eck, 2001). This trend has been reported from early school through adult life, and from diverse geographical sources (Broos, 2005; Heemskerk, Brink, Volman, & Ten-Dam, 2005). Although some scientists have argued that this pattern is changing (Colley & Comber, 2003; Durndell & Thomson, 1997), surveys continue to show an imbalance between the sexes favoring males over females (Colley & Comber; Heemskerk et al., 2005).

The authors consider the consequences of this gender bias to be significant not only in terms of maximizing the whole potential workforce, but also because there is some evidence that males design information- and knowledge-based systems in ways that are different from females, and often these differences favor male users in communication and searching methods. The gender imbalance may become of increasing importance as high-technology industries, such as knowledge engineering and Web commerce, become the normal methods of conducting business throughout the global economy.

BACKGROUND

A scarcity of females in computing can be detected from the earliest levels in many educational systems (Durndell & Haag, 2002). It pervades through all levels of education and into industry (Jackson, Ervin, Gardner, & Schmitt, 2001). This trend could not only pose a threat to the economic growth and stability of the global economy, but it may also reflect a continuing gender inequality in society.

When we consider the individual differences that occur in humans, then gender, along with age, are often considered among the primary attributes that differentiate people from each other. In comparison to many of the differences such as intelligence, cognitive style, or social grouping, the difference of gender is relatively easy to determine; but like racial origin or social grouping, the topic of gender is often sensitive and highly controversial (Morgan, Brebbia, Sanchez, & Voiskounsky, 2004).

Explanations for these reported gender differences have been varied, but include genetic and hormonal sources (Brosnan, 2004), brain chemistry (Bransford, Brown, & Cocking, 1999), cerebral lateralization (Brosnan), and social roles (Morgan, 2005; Morgan, Gibbs, Macleod, & Morris, 1991; Morgan & Morgan, 2000; Morgan et al., 2004).

FUTURE TRENDS

Reviews of the literature of gender and technology show a consistent trend of male domination in the computing industry and education (Volman & Van-Eck, 2001). Although there appears to be no single reason for this domination, social roles and stereotypes are now thought to be of major importance in shaping education and vocational choices (Durndell & Thomson, 1997; Morgan & Morgan, 2000).

There is a growing body of evidence that suggests that there are strong parental influences on the attitudes and behaviors that we develop in later life. These influences include not only our views on appropriate gender-based behavior (Snyder, Velasquez, Clark, & Means-Christensen, 1997; Tidwell, Witt, 1997), but also our attitudes toward technology and even our self-rated proficiency in using technology (Morgan, 2005; Morgan et al., 1991; Morgan & Morgan, 2000; Morgan et al., 2004). It is the authors' view that in order to redress the gender imbalance inherent in the technological world of the future, greater emphasis should be placed on parental influence and also that of the educators to encourage females to explore and develop a positive technological attitude. Of equal importance is the establishment of more positive female role models, particularly with regard to the representation of women and technology in the media.

CONCLUSION

As yet, there are no universally accepted explanations for the sex differences found in computing. Broos (2005) conducted a large quantitative analysis of previous studies of the gender divide in ICT attitudes and found, in general, females had more negative attitudes toward computers and the Internet than did men. As we have seen, there is some evidence that social and cultural effects play a large role in gender differences. The mass media also can influence people's perceptions by the way in which they portray sex roles. Currently, males are usually portrayed as being the predominant users and being in dominant roles in any mixed-sex portrayals (http://www.media-awareness.ca/english/issues/stereotyping/women_and_girls/index.cfm).

One other factor that could explain the lack of females in computing is the harassment of females in the typically male-oriented workplace (Rutter, 1996). This reflects a sexist attitude of viewing females as sex objects rather than human beings or fellow workers. The task of addressing such unfair attitudes, stereotypes, and biased behavior will take considerable time, but it can only be hoped that a day will come when such unfair pressures are removed.

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KEY TERMS

Cerebral Lateralization: The theory that the attitude and behavior differences reported as existing between males and females are due to differences in brain specialization. Specifically, left-hemispheric activity is associated with male behaviors, and right-hemispheric activity is associated with female-type behaviors.

Cognitive Style: The high-level heuristics or principles that organize mental behavior. Some researchers propose that the natural cognitive style of males and females are not only different, but are responsible for many reported gender differences.

Gender Roles: The sets of behaviors and attitudes that a society or culture normally associates with males or females.

Sexual Harassment: Unwelcome and unlawful discriminatory behavior or attitudes that are related to sexual or gender roles.

Technology: The term technology is used within this article to cover the cluster of technologies that includes all aspects of ICT, networked computers, hypertext, hypermedia, the World Wide Web, and other adjuncts.

Technology Attitudes: The views held by an individual with respect to technology that influences not only his or her rate of voluntary use of technology, but also predicts stress levels when faced with situations that involve the use of unfamiliar technology.

Gendered Attrition at the Undergraduate Level

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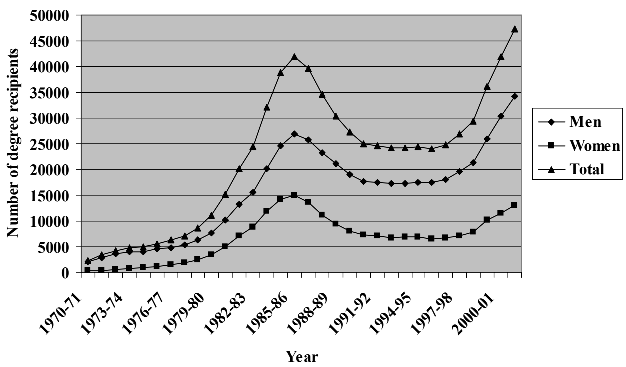
INTRODUCTION

As Camp showed in her widely cited papers on the "incredible shrinking pipeline" (Camp, 1997; Camp, Miller, & Davies, 2000), women have continuously lagged behind men in earning Bachelor of Science (BS) degrees in computer science (CS) at four-year post-secondary U.S. institutions, despite the fact that the percentage of women earning CS degrees has kept pace with trends in the total number of CS degree recipients. This pattern is illustrated in Figures 1 and 2, which are based on data from the National Center for Education Statistics (National Center for Education Statistics, 2003, Table 282).

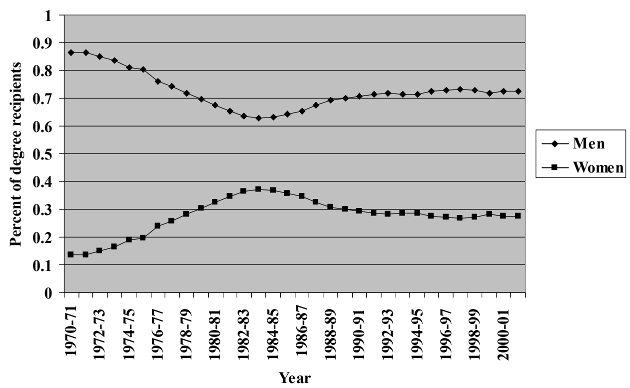
Our goal is to summarize the proposed causes of, and solutions for, female attrition at the undergraduate level. In times like the present, when the U.S. is experiencing an overall decline in enrollment in undergraduate CS programs (Zweben, 2005), it becomes increasingly important to retain good students—both men and women.

Figure 1. Earned degrees in computer and information sciences by gender for selected years, 1970-1971 to 2001-2002



Source: U.S. Dept. of Education, NCES Digest of Education Statistics, 2003

Figure 2. Percent earned degrees in computer and information sciences by gender for selected years, based on data shown in Figure 1

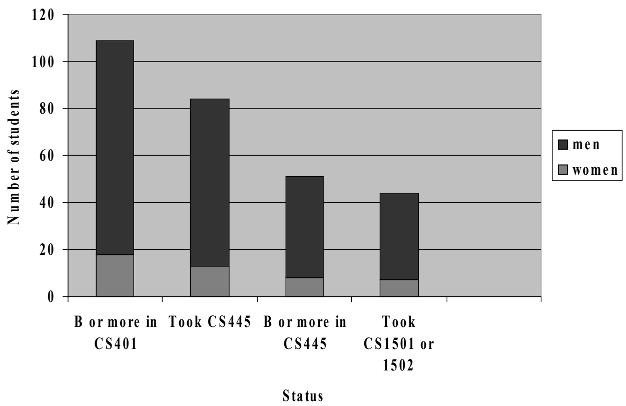


BACKGROUND

Two main forces contribute to the continuous underrepresentation of female BS in CS degree recipients: fewer women than men *enroll* in CS programs at the undergraduate level and more women than men *leave* these programs. Enrollment has decreased overall (across genders) since 2000, following the "dot-com" crash and increase in outsourcing of technical jobs (Zweben, 2005). The national average for female students in undergraduate CS programs is only 15%, according to the *New York Times,* May 22, 2003.

Recent research shows that attrition, like enrollment, is a gender issue. This point is graphically demonstrated in Cohoon's (2003) study of 210 medium to large undergraduate institutions in the United States. The percentage of women who left the CS major from the period 1994/95-1999/00 was 45% on average, compared with 21% for men. Research by this author and her colleagues (Katz, Aronis, Allbritton, Wilson, & Soffa, in press) corroborates Cohoon's findings. For example, Figure 3 portrays

Figure 3. Loss of students earning B or above in CS at two stages of an undergraduate curriculum



the loss of students who earned a B or above in CS courses at the University of Pittsburgh at two points in the undergraduate CS program, during the period 2000-2004[1]: after taking an introductory course (*Intermediate Programming Using JAVA,* CS401) and after taking *Data Structures* (CS445). Sixty percent of men who completed CS401 with a B or above vs. 43% of women continued to the second course, CS445, a marginally significant difference ($\chi = 3.2$, $p < .07$). A similar pattern held for the transition from CS445 to the next course in the sequence, *Algorithm Implementation* (CS1501) or *Formal Methods* (CS1502), depending on which course students chose to take first (Katz et al., in press). This study also found that men who earned less than a B in the introductory courses (CS401 and CS445) were more likely to continue in the program than were women who earned less than a B. Because this study was conducted at a single institution, further research is needed to determine the extent to which these findings apply to other CS programs and to explain them.

CAUSES OF GENDERED ATTRITION

Research conducted mainly in the past decade has revealed that gendered attrition is a complex, multifaceted, multi-level problem. Numerous factors contribute and the problem percolates upwards through various levels—from the individual student through departmental, institutional, and disciplinary levels (e.g., Cohoon, 2002, 2003; Davies, Klawe, Ng, Nyhus, & Sullivan, 2000).

Student Characteristics

A complex array of affective, cognitive, and behavioral characteristics predict female attrition from CS programs. Affective factors include women's lack of confidence in their ability to succeed (Beyer, Rynes, Perrault, Hay, & Haller, 2003), which may lead to a lack of interest and sense of isolation (Margolis & Fisher, 2002). Cognitive factors include attribution of poor or suboptimal performance to lack of ability rather than lack of effort, as men are more inclined to do (Davies et al., 2000), and the belief that a career in CS is incompatible with the goal of raising a family (Scragg & Smith, 1998). Behavioral factors include less prior computing experience than men, which can contribute to lack of confidence and adoption of strategies for coping with being a minority that can breed isolation from one's own peer group. For example, trying to fit the "male hacker" image may alienate female CS students from other women who refuse to fit this stereotype and instead strive to cultivate diverse interests (Etzkowitz, Kemelgor, Neuschatz, & Uzzi, 1994; cited in Kassianidou, Letchner, Mathes, Sekar, & Yu, 2001).

Departmental Characteristics

Departmental factors that have been cited as contributors to female attrition from CS programs fall within three categories: lack of peer support, lack of faculty support, and problems with the CS curriculum. Lack of peer support has been observed in the form of harassment and ignoring female students (Von Hellens & Nielsen, 2001). Lack of faculty support also manifests itself in various ways, including classroom behaviors that favor male students, such as calling on men more often than women (Bunderson & Christensen, 1995); few female role models (Davies et al., 2000); insufficient attention to students of both genders, often due to excessive teaching and research requirements which leave little time for mentoring (Binkerd & Moore, 2002); and overly stringent grading policies (Cohoon & Chen, 2003).

Criticisms of CS curricula have been mixed. Some researchers have argued that more mathematics is taught in CS courses than is necessary and than appeals to women's interests (West & Ross, 2002). Others have argued that, on the contrary, mathematics, logic, and problem solving form the core of what draws both genders to CS and these foundations are undermined by curricula that emphasize programming languages and hardware (e.g., De Palma, 2001). There is similar disagreement concerning when applications of CS concepts should be stressed: in selected CS courses (Blum & Frieze, 2005; Davies et al., 2000); throughout the undergraduate CS curriculum (Cohoon, 2002; Margolis & Fisher, 2002); or throughout the entire undergraduate curriculum—that is, in CS and other courses (Leever, Dunigan, & Turner, 2002).

Institutional Characteristics

One contributor to female attrition at the institutional level is insufficient financial support for computing facilities, safety, etc. (Binkerd & Moore, 2002). In a provocative follow-up study to Margolis and Fisher's (2002) seminal work, Blum and Frieze (2005) found that many things that *appeared* to be fundamental gender differences in Margolis and Fisher's study—for example, that men love programming for its own sake, while women view programming as a tool to solve real-world problems—were actually an artifact of a deep-rooted problem at the institutional level: admissions criteria that favored the "geek" stereotype and, conversely, disfavored a diverse student body. When Carnegie Mellon University (CMU) reformed its admissions criteria to downplay the importance of prior computing experience and to instead favor talented (high-achieving) students with diverse interests, the social climate in the CS department changed dramatically. As Blum and Frieze state, "in a more balanced environment, gender differences tend to dissolve" (p. 1) "…a transitional culture gave 'permission' for the men to explore their non-geeky characteristics and the women encouragement to be both feminine and computer focused" (p. 9).

Disciplinary Characteristics

Recently, some educators have argued that students are leaving (or not entering) CS programs because the field itself has not set big, exciting goals. According to Peter Lee, Associate Dean of the undergraduate CS program at CMU, "it's hard for voice over Internet Protocol or e-commerce to compete with finding the age of the universe" (Lee, quoted in Frauenheim, 2004, p. 2).

PROPOSED SOLUTIONS TO GENDERED ATTRITION

Recommendations about how to reduce gendered attrition follow naturally from the causes discussed in the preceding section. They span multiple levels, from reform efforts at the departmental level to fundamental changes within the CS discipline itself—most notably, emphasizing the "grand challenges" of CS and communicating these goals in the media and classroom (Lee, quoted in Frauenheim, 2004). Reform efforts at the departmental and institutional levels have the potential to impact student characteristics that may cause low female enrollment and high attrition at the undergraduate level. Specifically, they can increase women's confidence in their computing ability and sustain their interest and sense of belonging in the field. Societal changes, such as increased representation of women in the popular media as competent players in information technology, and parental encouragement to pursue IT careers, should also have a positive impact on enrollment and retention of women in post-secondary CS (or related) degree programs. Table 1 summarizes proposed solutions to gendered attrition at various levels. (See also Cohoon 2001, 2002).

Reform Efforts for Whom?

Should enrollment and retention-raising interventions be designed specifically for women? Several scholars have pointed out that curriculum reform efforts targeted at women face criticism and resistance—from the CS department, male students, and women who do not want to be "singled out" or labeled as "feminists" (e.g., Blum & Frieze, 2005). On the other hand, Blum and Frieze argue that there is a place for auxiliary programs aimed at leveling the playing field for women—for example, CMU's

Table 1. Summary of proposed solutions for gendered attrition

Departmental Actions
Increase peer support • Establish a women's CS organization
Increase Faculty Support • Raise awareness of the impact of faculty behaviors in the classroom
• Increase number of female role models
• Improve scholarly quality
• Involve students in research
• Implement fair grading policies
Modify the curriculum • Stress applications throughout the CS curriculum, in selected CS courses, or throughout the undergraduate curriculum (i.e., in CS and other courses)
• Provide internships for students
• Make CS less formal/mathematical; alternatively, pay more attention to problem solving, logic and mathematical foundations
• Provide multiple entry routes into the CS curriculum
Institutional Actions • Provide faculty incentives to mentor students
• Take efforts to maintain faculty stability
• Use outreach activities to boost female enrollment
• Broaden admissions criteria to encourage diversity
• Provide financial support for computing facilities, safety, etc.
Disciplinary Actions • Emphasize the "grand challenges" of CS and communicate these goals in the media and in the classroom

successful Women@SCS organization (Frieze & Blum, 2002), which provides female CS students with the social and academic network that men naturally have, by virtue of being in greater numbers. Perhaps the optimal approach is to target curriculum and institutional reform efforts at retaining all students, reserving women-centered programs for gender-based problems.

FUTURE TRENDS

The research on the causes of, and solutions for, gendered attrition at the undergraduate level discussed in this chapter raises the need for three main avenues of research: research to uncover more of the deep-rooted causes of gendered attrition, to evaluate reform efforts, and to learn from cultures wherein women are well represented in academic CS programs or the IT workforce.

Uncovering the Deep-Rooted Causes of Gendered Attrition

We have learned that some factors that we did not suspect contributed to gendered attrition are at least indirectly involved. For example, since various studies have shown that women perform as well (or better) than men in CS programs (e.g., Davies et al., 2000; Margolis & Fisher, 2002), achievement has not traditionally been the focus of investigations into the causes of gendered attrition. However, recent research has uncovered the subtle role that achievement plays in women's decision to leave CS: failure to meet performance expectations encourages many women to withdraw, when they lose confidence and interest (Katz et al., in press; Margolis & Fisher, 2002). Correspondingly, Blum and Frieze (2005) observed that commonly cited causes of attrition, such as women's sense of isolation, are actually surface manifestations of covert causes, such as overly constrained admissions policies (Blum & Frieze, 2005).

Future research should strive to identify more of these subtle causes and the solutions that follow from them. For example, we need to determine why it is that women appear to be more deeply affected by grades than men (Katz et al., in press), when this difference begins, and what (if anything) can be done to prevent women from making unwarranted interpretations of suboptimal performance—that is, to recognize when a B or less means that the student is truly not suited for CS, as opposed to an indication that high grades are difficult to obtain in a particular course or the major at large.

Assessing Reform Efforts

Some studies have investigated the effectiveness of mentoring and role model programs, which are frequently-suggested remedies for gendered attrition, and the results seem promising (e.g., Townsend, 2002). More studies to evaluate interventions are needed. They should directly measure attrition rates. For example, CMU's comprehensive reform efforts have certainly done much to increase female enrollment and to positively alter peer relationships at this institution (Blum & Frieze, 2005). However, it remains to be seen if these efforts will also increase retention. Preliminary data suggests that they will (Margolis & Fisher, 2002).

Gaining Insight from Select Groups

Galpin's (2002) study of female participation in computer science and related fields in more than 30 countries found that, overall, the gender gap in participation in undergraduate CS-related programs is international. We believe that much could be learned from those countries that fall in the 40% and above range in female participation at the undergraduate level and in the IT workforce. For example, Uden (1994; cited in Galpin, 2002) found that various factors could explain why, in 1987, more than 50% of system programmers and designers and the majority of post-secondary CS degree recipients in Singapore were women, including "government promotion of the use of computers, perceptions of good career prospects in IT, a preference amongst women for computing as opposed to engineering which also pays well, exposure to computers at schools [sic] level in a gender-neutral manner, and assistance with domestic responsibilities by older family members or employees" (p. 95).

Closer to home, Lopez and Schulte (2002) observed that the gender difference in receipt of BS degrees at U.S. institutions shown in Figures 1 and 2, particularly for the years 1989-1997, disappears when we look at African American females, mainly those who attend historically Black colleges and universities, as opposed to all women. As the authors conclude, African American women are "a group to be studied" for clues as to why their persistence in the undergraduate segment of the IT pipeline is strong.

CONCLUSION

The loss of women from the undergraduate segment of the IT "pipeline" stems from multiple causes, at various academic and societal levels. Although multifaceted efforts to reduce gendered attrition will most likely be effective, we should bear in mind that formal training in CS at the undergraduate level is only one of several viable pathways into the IT workforce. For example, some students (men and women alike) choose to major in one of the basic liberal arts or sciences at the undergraduate level and then pursue an advanced degree in CS or information science; other students receive technical, on-the-job training or take continuing education courses after they graduate. Hence, we must be careful not to inflate the negative implications of statistics on declining enrollment and retention in BS in CS programs for the future of the IT workforce. We should also bear in mind that some students make a well-reasoned decision to leave CS and go on to contribute to other fields. In our view, one of the greatest challenges for education, in both formal and informal settings, is to instill the basic knowledge and learning skills that students need to be successful "lifelong learners," so that those who leave the CS pipeline prematurely, or who choose not to enter it, have the option of (re)-entering at a later time. Identifying what knowledge and skills are needed to do this, and how to help students acquire the same, are important questions for instructional research.

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KEY TERMS

Gendered Attrition Rate: The gap between men and women in the rate of attrition from undergraduate CS programs.

Instrumentals vs. Balancers: Contrasting strategies for dealing with being a minority. In CS, female instrumentals try to be like "one of the guys," adopting obsessive "hacker" behaviors and renouncing their femininity. Balancers, on the other hand, maintain diverse non-computing interests, strive to achieve a balanced lifestyle, and preserve their feminine identity (Etzkowitz, Kemelgor, Neuschatz, & Uzzi, 1994; cited in Kassianidou et al., 2001).

Mentors vs. Role Models: Mentors are men and women who offer their time and energy to develop students' knowledge and skills in a particular discipline. Role models serve as a positive example for a particular group; for example, female computer scientists, CS instructors, or more advanced CS students.

Performance Expectations: Beliefs about the likelihood of attaining a particular level of achievement.

Pipeline Shrinkage Problem: The "pipeline" is a metaphor for the ratio of women involved in CS or related fields from high school through graduate school and into the IT workforce. As Camp (1997) and Camp et al. (2000) demonstrated, this ratio falls at increasingly higher levels.

Taulbee Survey: Annual survey conducted by the Computing Research Association to document trends in student enrollment, employment of graduates, and faculty salaries.

"We Can but I Can't" Phenomenon: A woman's belief that there is no difference in general between males and females in computing skills and ability, but that she personally lacks the ability to succeed in CS (Volman, 1997; cited in Davies et al., 2000).

ENDNOTE

[1] Few students of either gender who earned less than C in the introductory course continued in the program. We focused on students who earned a B or above because these students hold the most promise for being able to meet the high standards of the information technology workforce.

Girls and Computing

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INTRODUCTION

Much research conducted between 1977 and 1990 document the existence of a technological gender gap (Canada & Brusca, 1991) which has been studied extensively throughout the 1990s. This article provides an overview of research related to a specific segment of the digital gender divide: young girls and computing. This background, described as different waves of research, is followed by a discussion regarding the remedial actions aimed at making more young girls computer users, and implicitly also inspiring more women to study computer science. This latter aim is related to the women *in* computing problem, concerned with the lack of women in computer science, which is often seen as a consequence of the girls *and* computing problem.

BACKGROUND: WAVES OF GENDER GAP RESEARCH

Computing is Perceived as Masculine

There are few contributions actually suggesting that biological sex differences can explain why computers are associated with men (Hawkins, 1985). However, school computers were typically linked to mathematics and programming, while home computers were associated with violent computer games with competing male protagonists. Thus, both home and school computing has been perceived as masculine and seen to prevent girls from developing an interest in computing (Bromfield, Clarke, & Lynch, 2001; Charlton, 1999; Hawkins, 1985). Since computing was stereotyped as a masculine activity, gender "conscious" girls refused to be associated with computers (Newman, Cooper, & Ruble, 1995). Girls' orientation away from computing was further strengthened by initial attempts to teach narrowly about the technology and programming, and by situating computer education within the perceived masculine areas of science and mathematics (Charlton, 1999; Makrakis & Sawada, 1996).

Girls Have Other Interests Than Becoming Computer Engineers

Both girls and boys see the advantages of computers in their everyday life, but girls are generally less interested in learning how to use them. This apparent lack of interest may be related to girls' lack of self-confidence despite proving themselves competent (Shashaani, 1993). The "we can, I can't" paradox means that young girls have a tendency to feel insecure about their own computing abilities, at the same time as they feel that women in general are as competent as men (Makrakis, 1993; Reinen & Plomp, 1993).

Girls tend to be confident although pragmatic computer users when studies or jobs require the use of ICT (Durndell, Glissov, & Siann, 1995). Girls want to use ICT to make learning more interesting. They are motivated by observable usefulness (Håpnes & Rasmussen, 1997). This apparent lack of interest in computing may also be due to biases in the research (Stuedahl, 1999) or that the research has not fully grasped how girls define and talk about computing. Many girls do not perceive their own playful computer use as "proper computer use." The latter is defined as instrumental use like fathers do at work. "Proper computer users" are asocial boys who spend too much time in front of the computer (Gansmo, 1998).

Many girls construct a gender identity through "good girl" ideals (Kvaløy, 1999). The strive to be a "good girl" goes along with perceptions of the computer as a boring but useful tool. Girls with lower ambitions for their school work and future career and girls with more varied and hands-on experience with computers, are more inclined to learn more computing because of a less limiting idea of "proper computer use" (Gansmo, 1998; Nordli, 1998).

Many studies show that boys and girls differ in their enthusiasm for computers. Even though both may see computers as generally important in society (Livingstone & Bovill, 1999), more boys than girls rate computer skills important in their future (Holloway, Valentine, & Bingham, 2000). Consequently, boys are more inclined to study computer science.

A typical "girls' use" is writing, using a word processor to write poems, diaries and stories. Girls also like to communicate and to use the Internet for information gathering (Håpnes & Rasmussen, 1997). Thus, girls seem to apply computers as a tool in people-to-people interaction (Hanor, 1998). Even girls who are reasonably confident at computing are not necessarily drawn to the discipline: "we can, but I don't want to" (Durndell, Glissov, & Siann, 1995).

Computers are Different, But so are Girls too

The cultural meaning of computers is flexible (Livingstone & Bovill, 1999). The present generation of pupils will become acquainted with several kinds of computer applications in their everyday lives (Volman, 1997). Computer applications differ between homes and schools (Drotner, 2001), and include diverse and opposing tasks such as entertainment versus education, games versus work and so on (Gansmo, 2004; Hagen, 2003).

Computer use at school offers limited space for the playful activities girls find attractive, such as design, drawing, painting, surfing, and chatting. Further, girls' general refusal of the computer as technology and particularly of computer games may be seen as a symbolic downgrading of boys' intense and playful action culture. This downgrading implicitly contributes to upgrade the relational and intimate nattering girls' culture (Drotner, 2001), at least among the girls. This indicates that girls are not victims of technology. They have made an active choice (see Volman, 1997; Wyatt, 2003).

Through focusing on use it is observed that the range of computer applications available shape gender differences in pupils' attitudes to computing—computers have a variety of potentials, some of which appear to be more attractive to girls, other to boys. Some studies also highlight competing masculinities and femininities, suggesting that important differences exist within the categories "male" and "female" as well as between them (Gansmo, 2004; Holloway, Valentine, & Bingham, 2000). Such studies complicate the gender binary by showing that gender constructions are relational and mainly informed by heterosexual relations. Holloway, Valentine, and Bingham (2000) found that several secondary school boys regarded the techno interested boys as feminine and/or gay, which indicates that computing may not be linked to the kind of hegemonic masculinity associated with physical abilities like playing football.

However, most pupils claim that there are no differences between girls and boys. Girls who are interested can do it as well as boys (Lemish, Liebes, & Seidmann, 2001; Volman, 1997). Volman calls this the free choice repertoire, and explains this as lack of repertoire where gender inequality or gender-neutral positions can be denoted. Boys more often than girls apply an expert repertoire when talking about computers, while girls frequently apply an outsider repertoire. Instead of posing themselves as experts, girls are more down to earth in their conversations about computers, and they also present themselves as less skilled than the researcher found them to be. Accordingly, boys frequently posed as more skilled then they were found to be (Vestby, 1998; Volman, 1997). To the girls the free choice repertoire means that they are not passive victims of gender inequality, and the outsider repertoire implies that they contribute by choice to their own exclusion from the technology. These repertoires might hamper learning processes and should thus be tried replaced with new repertoires, for instance a user repertoire (Volman, 1997).

REMEDIAL ACTIONS

The low number of girls and women taking an interest in ICTs still gives reason to worry (Bromfield, Clarke, & Lynch, 2001). Boys have better access to and make more and also more varied use of computers than girls do. Gender gap documentation shows that without interventions, men and women demonstrate different computer-related attitudes and behaviors (Canada & Brusca, 1991). Thus, several intervention programmes have been initiated.

Give Girls Feminine Technology

Girls have been less interested in computer games than boys have (Buckingham, 2002; Vaage, 2002). Familiarity with computer games may encourage confidence in more "serious" computing. Albeit this relation is seen as hard to test, Livingstone and Bovill (1999) suggest that if there were more games for girls, they may gain more confidence in their computing skills. Software for girls must be produced to attract more girls to use computers (Newman, Cooper, & Ruble, 1995). Actually, some software designers have devised special "girl software" intended to tap into girls' interests. Some attempts were moderately successful while others resulted in software that was less interesting or reinforced female stereotypes (Rommes, Oudshoorn, & Stienstra, 2003; Stewart, 2003; Sutton, 1991). Rather than making software especially for girls, it is also suggested to include girls through applying the technology in ways girls find authentic and realistic (Volman & van Eck, 2001).

Such intervention programmes attempt to recruit girls through offering them a feminine technology based on assumptions that girls are a homogeneous group in marked contrast to a homogeneous group of all boys. These remedial actions can be described as a mix of efforts to acknowledge women the same rights as men (access to technology) and efforts to acknowledge that women's values and experiences are different from men's (the right to a different technology). Such intervention programmes do not challenge the dualisms of gender at all, but rather reinforce gender dualisms and hence also a gender-technology hierarchy (see Faulkner, 2000). Girls are expected to go from total absence via the lower steps of the hierarchy to the top of the "masculine technology." Through changing the technology it is hoped that girls will improve. A variety of this is found among some game designers who rather emphasize that high quality games will attract more users from both sexes, and thus design their games to cater for the interests of different girls and different boys (Gansmo, Sørensen, & Nordli, forthcoming).

Improve the Girls

Many schools emphasize the importance of female role models. One of the most commonly applied inclusion policies among gender aware schools has been to train women teachers in computing and to select women as supervisors for other students' computer activities (Reinen & Plomp, 1993).

Girls are not interested in competing with the boys' "mad rush" for computer access. In classrooms where equal access is ensured, girls can concentrate on learning and enjoying computer skills (Watkins & Brimm, 1985). When boys appear as pushing the girls out and also as more confident and dominating, this is tackled in some schools by offering computing in single-sex groups and by teachers actively encouraging girls to participate (Livingstone & Bovill, 1999).

Such intervention programmes aim to improve girls' skills and confidence. Through securing access to computers and improving girls' skills and confidence, they will be better fit to adapt to the masculine computer culture. However, neither gender dualisms nor technology are questioned or criticized within such a perspective.

Just Use IT

In the UK, twice as many children use computers in schools compared to at home. Schools thus appear to act as an "equalizing force" (Livingstone & Bovill, 1999). Introduction of computer literacy courses in lower secondary schools in the Netherlands diminished the difference in ICT knowledge between girls and boys, but it was not able to remove gender differences in attitudes (Volman, 1997). Similar skepticism towards school as an "equalizing force" is also voiced by Nordli (2001) who found that computer enthusiastic girls in secondary schools in Norway mainly learned their skills at home through trial-and-error. The relatively successful reconfiguration of the gendering of computers that may be observed in Norway seems only marginally to be brought about through the education system. The most important factor is the swift diffusion of Internet access (Gansmo, 2004; Nordli, 2001).

It might seem as Volman's (1997) recommendation of establishing user repertoires for the pupils is efficient since schools which had an official emphasis on use rather than teaching of technology, inadvertently achieved smaller gender differences in out-of-class computing as well (Gansmo, 2003; Holloway, Valentine, & Bingham, 2000).

The main effort should be to integrate ICT into the curriculum (Livingstone & Bovill, 1999), and to integrate computing in several subjects since more experience also opens for more positive experiences with computers (Jones & Clarke, 1995). However, this trivialization of computing does not inspire the teens to study computer science, and the women *in* computing problem is consequently not remedied by this strategy (Gansmo, 2004).

FUTURE TRENDS

Despite wider diffusion of computers and more computer applications, changes in how teens use and think about computers and several intervention programmes, the girls and computing problem seems to be constantly present in one way or another. This is related to the pervasive understanding of gender as a binary and the resulting gender-computing construction with a dichotomous hierarchy where girls are seen to lose (see Faulkner, 2000). Several new studies stress the importance of seeing gender and technology as co-produced or co-constructed, thus avoiding problems with essentialist understandings of both gender and technology. Rather than á priori and static categories, gender and technology are seen as processes mutually influencing each other (Faulkner, 2001; Sørensen, 2004). Further studies and intervention programmes should thus bear in mind that there is not one simple relation between gender and computing; one size does not fit all. Gender and ICT are not fixed categories that can be investigated once and for all (Rommes, Slooten, Oost, & Oudshoorn, 2004).

CONCLUSION

Much of the research and intervention programmes suffer from lack of elaborations on gender and technology. Binary gender comprehensions are not questioned or problematized, neither is the importance of the "masculine" field of computer science. Whereas some studies directly place the problem with the girls, more recent research is less oriented towards recruiting girls and more towards analyzing the variety of use. This also implies the acknowledgement that technology is not necessarily beneficial and that non-users may be so by choice. The focus on girls' use of computers offers important lessons. Heterogeneous use contributes to heterogeneous gender comprehensions, and vice versa. When computing is understood as diverse tasks, the user groups multiply from active boys and absent girls to different actors from both sexes leaving computing more gender authentic for different girls as well (see Faulkner, 2001). Still, given the enduring problems with girls in computer science, it is evident that ICT development cannot be seen separate from gender equity discussions. Future research and remedial actions must thus be based on heterogeneous understandings of both gender and ICT as processes.

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KEY TERMS

Computing: In this article, computing refers to the *use* young girls make of ICT, either in school or in leisure, or their understanding of such use—as opposed to adult women studying computer science.

Digital Gender Divide: Digital divide refers to the division between those who have and have not access to ICT. The digital *gender* divide refers to the fact that men often represent the "haves" while women represent the "have nots".

ICT: Information and communication technology.

Intervention Programmes: In this case, intervention programmes are understood as remedial actions and larger programmes aiming at closing or narrowing the digital divides.

Remedial Actions: In this case, remedial action is understood as actions taken by government, schools, or other parties to diminish the technological gender gaps.

Technological Gender Gap: Refers to the gap between men and women when it comes to access to, interest in and use of technologies, like for instance ICTs.

Young Girls: In this article, "young girls" refers to teenage girls, and the focus is placed on their use of computers in school or leisure—as opposed to adult women studying or working within computer science.

Girls, Games, and Intrepid Exploration on the Computer

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INTRODUCTION

One way to increase women's participation in technology is to create more female independent problem solvers on the computer, or what Sherry Turkle (cited in Margolis & Fisher, 2002) calls "intrepid explorers." Studies of students who persist in computer science have shown the importance of being "intrepid"—having the desire to explore without fear of breaking the computer, and the confidence to solve problems and deal with setbacks (Margolis & Fisher, 2002). An intrepid explorer is creative and fearless about trying new things on the computer. However, how do people become intrepid explorers? How can learning environments support them? This article addresses these questions by describing ways to support girls to explore intrepidly on computers. These strategies are grounded in previous research as well as our own research on an after school program for middle school girls.

BACKGROUND

Females are still under represented in the world of technology. The percentage of women studying engineering, computer science, and related fields in U.S. universities has dropped from 36% to 20% in the last two decades (National Science Foundation, 1999). Even when they are interested in information technology (IT), girls are less likely to pursue and persist in a high tech career because they tend to believe it is solitary work, entails competition rather than collaboration, and has little social value (AAUW, 2000; Lightbody, Siann, Tait, & Walsh, 1997; Margolis & Fisher, 2002). Recent research suggests that the gender gap in confidence and use of computers is narrowing, although there are still some gender differences in how computers are used (Colley, 2003; Miller, Schweingruber, & Brandenburg, 2001).

Programs to increase the number of girls who pursue and persist in technology must build on research. Women's *persistence* in computer science in college has been linked to peer support, experiences of success in some aspect of computing, seeing computers as useful for expression and for helping society, and rejecting "computer geek" stereotypes (Crombie & Armstrong, 1999; Margolis & Fisher, 2002). Women are more likely to persist when they collaborate while working on the computer (McDowell, Werner, Bullock, & Fernald, 2003).

The National Science Foundation recently released a book called *New Formulas for America's Workforce: Girls in Science and Engineering*, which describes many innovative programs designed to increase girls' interest in technology. Most build on research, but few target middle school students, a critical time for choosing career identities, and none focuses on creating intrepid explorers. There is a great need for theories and models of learning to guide both the integration of research findings into middle school educational settings, and the measurement of the effects of these efforts.

In this article, we first describe a model of intrepid exploration that can provide a framework for efforts to increase girls' participation in IT. We then describe several program strategies that parents and educators can use to support girls to become intrepid explorers on the computer. Finally, we present research on a program offered after school and during the summer to middle school girls.

STRATEGIES TO INCREASE GIRLS' PARTICIPATION IN IT

Intrepid explorers are able to problem-solve and explore without fear of making a mistake or getting lost, and have the confidence to deal with setbacks and errors (Margolis & Fisher, 2002). In our model, an intrepid explorer on the computer demonstrates five capabilities: computer fluency, self-efficacy, problem solving skills, curiosity, and creativity. Table 1 provides examples of each of the five characteristics, which are derived from research on the *Girls Creating Games* (GCG) program. The program is described in more detail in Denner, Werner, Bean, & Campe (2005). The research data include one-on-one interviews, electronic notebooks, and an online survey that measures skills, interests, and attitudes toward computers. The 126 program participants live in a small urban area in California, and are between 10-14 years old (M=11.73, SD=1.0). The girls' ethnicity is mostly white (60%) and Hispanic/Latina (31%), and 36% report that they speak a language other than English at home at least some of the time. Below we describe several program strategies created for and tested within GCG, as well as some of our research findings on whether the strategies were successful in promoting intrepid exploration.

Strategy 1. Increase Computer Fluency

In order to build fluency, programs must build computer skills, capabilities such as managing problems and working with others, and concepts such as understanding modeling and abstraction (Committee on Information Technology, 1999). To this end, the GCG program focuses on creating games and providing instruction in the use of Flash multimedia and animation software (http://www.macromedia.com/). The games are interactive stories, where the player must choose the next step at key points in the story. The girls write their stories and become personally invested in their games, which provide motivation and a context for learning and practicing their computer skills. They add graphics and music, and use Flash's programming language to create animation, and interactive buttons and text elements. Cassell (1998) suggests that storytelling can be used to change the relationship between gender and technology. In fact, our survey data show that participants improved on a range of transferable computer skills, such as how to use keyboard shortcuts, how to work with graphics, and how to work with two software programs at once.

A collaborative learning structure called "pair programming," where two users sit together at one computer (Williams & Kessler, 2000) is also used in

Table 1. Characteristics of intrepid exploration on the computer

Computer fluency	• Demonstrates skills, concepts, and problem solving capabilities across software • Demonstrates a conceptual understanding of IT by asking questions about new ways to use software or how the software is set up • Does not ascribe "magical properties" to the computer • Has a language to describe what they learned
Self-efficacy	• Has confidence; sees oneself as good at some aspect of computing • Has a sense of control; attributes success to ability rather than luck • Does not define oneself as "not good at computers" if they make a mistake • Rejects negative stereotypes about girls and computers
Problem solving skills	• Likes to be challenged • Uses unexpected computer behaviors as information • Able to keep working and/or identify solutions when frustrated • Not afraid to make a mistake; resilient in the event of mistakes • Generates solutions for solving a problem
Curiosity	• Actively seeks out new things to learn on the computer • Tests the ranges and limits of different software or programming languages • Enjoys learning and discovering new ways to do things • Seeks new sources of information about the topics she is curious about
Creativity	• Goes beyond the minimum project requirements • Uses the computer to communicate or express ideas • Attempts to use software or programming languages in new ways • Uses humor

GCG to increase fluency. Individual members of a programming pair switch off being the "driver" who operates the keyboard and mouse, and being the "navigator" who monitors the driver's work for errors and provides guidance by locating and using outside resources such as other people or books. Working in a pair encourages girls to try new things, and they report that one of their favorite parts of the program is meeting new people and spending time with friends.

Strategy 2. Promote Self-Efficacy

Several program strategies are designed to build self-efficacy; the perception that one is good at working with computers. Self-efficacy develops through mastery experiences, observing others, receiving encouragement, and experiencing low frustration (Bandura, 1997). As suggested by Gee (2003), for learning to occur we must build bridges between any negative identities and the potential of succeeding with computers. The GCG program does this by giving girls the opportunity to have mastery experiences to build confidence, deconstruct negative stereotypes about people who are skilled with computers, and identify a range of self-identities that are consistent with being good at computers, including being a programmer or artist.

The program builds efficacy by offering encouragement through regular affirmations. Girls receive anonymous, written acknowledgements or compliments about their behavior or performance from their peers. Pairs get awards for being the "pair programmers of the week" or the "problem-solvers of the week," and specific feedback on what they did well. The affirmations and awards reinforce the idea that girls are highly capable producers with technology, and the survey data show a significant decrease in the view that boys do better than girls when working on the computer.

Another way to increase girls' self-efficacy is to challenge negative stereotypes about who is good at computing. These views include the belief that people who work with computers are solitary, make no positive contribution to society, and do not have a social life or a family. In one activity, "Finding Out about Values and Interests," girls in GCG do a career interest self-assessment, and participate in a discussion that reveals that the girls who are considered by their peers to be good with computers often do not score high on technical skills. The adults lead a conversation about why certain "types" of people are considered good with computers, and reinforce the idea that computing requires a range of skills that include creativity, planning, and collaboration. In "Finding Out about Jobs and Skills," girls link what they are learning in the program with a range of jobs at a fictitious computer game development company.

Strategy 3. Encourage Independent Problem Solving

To increase the number of women who use and produce new technologies, educators must support more independent problem solving on the computer (Committee on Information Technology, 1999). In GCG, instruction is based on the neo-Vygotskian (1978) model of teaching as assisted performance, where "scaffolds" are provided to keep a child in the zone of proximal development (ZPD). Challenges that exceed a student's ZPD make learning more difficult and may undermine their motivation to pursue and persist in technology. Scaffolds in GCG include coaching from adults and peers, and problem-solving steps to avoid rescuing girls when they were stuck. For example, adults ask participants to describe their problem, seek answers from printed resources, and ask peers for help. They also provide visual reference sheets with step-by-step instructions for completing specific operations in Flash. When a problem still requires adult help, they use a technique called "strategic questioning." Rather than simply identifying the source of the problem or its solution, they ask girls a series of questions that point them in the right direction. This was often sufficient for girls to generate a solution by themselves.

Adults balance keeping girls in their ZPD by not rescuing, while also ensuring that girls do not reach a level of frustration that undermines their development of positive self-efficacy on the computer. Our research data suggest that girls at all skill levels perceived an increase in their ability to problem solve. In their surveys at the end of the program, more girls said that if they did not know how to do something on the computer at school, the first thing they would do is try to figure it out themselves (57%

compared to 35% at pre-test). As one girl said: "Now when I'm on the computer, even if I'm not on the Flash program, I kind of can figure out things better." Another commented: "One thing I really like about [the program] is that we learn programming abilities and develop something to almost always figure out our problem."

Strategy 4. Cultivate Curiosity

Two activities are designed to encourage girls' curiosity about what kinds of things they could do with the computer. In an activity called "Flash candy," pairs access links to ten other websites where Flash has been used to create games or multimedia projects that appeal to middle school girls. These links illustrate the many capabilities of the software, and provide ideas for what participants could do with this type of software in their game projects.

The second activity designed to cultivate curiosity is called "individual free exploration time." Girls in the program stated they wanted more opportunities to simply "play" with the software, and some wanted to work alone at the computer. They primarily used the free time to draw pictures and create animations, which they often included in their game.

Strategy 5. Provide Opportunities for Creativity

Research shows that girls consider the opportunity to express themselves and their creativity as one thing they like about computers (Cassell, 1998). Studies of another program found that "opportunities to experiment, to try new things, and to be creative, all helped the girls to achieve confidence with technology. A variety of choices and options allowed the girls to develop their personal styles of relating to the computer…" (Cone, 2001, p. 178). Like others have done in coeducational settings (Kafai, 1995; Liu & Hsiao, 2001) the GCG program puts girls in the role of designers and encourages creativity by giving them the skills and supports to create an *original* computer game, utilizing their individualized interests in narrative, music, and digital images.

To date, 48 games have been created in GCG and posted on the Internet. A thematic analysis of these games suggests that most girls went beyond the minimum requirement to create a simple story—they used the game as an opportunity to work through their questions and concerns. The most prominent theme was the way they expressed and worked through fears in their stories. Some fears took place in realistic settings, such as "The Bad Babysitter" where the child gets lost and a fire occurs, and "My Big School Test," in which the player might fail a test or get detention. Many of the games addressed fears of social exclusion and judgment resulting from peer pressure to skip school, or having friends discover you listen to certain kinds of music. Other fears were grounded in fantasy, such as "A Horrifying Alienistic Experience," where aliens invade the school, and "When Cheese Attacks," in which the player battles a piece of cheese that has invaded their school. Unlike most popular computer games, the girls created games that challenge social norms (such as talking back to a teacher), have little violence, and offer personal triumphs based on helping or saving others, or doing well in school.

FUTURE TRENDS

How can we continue to promote intrepid exploration among girls? In addition, will this approach increase the numbers of girls and women who pursue and persist in technology studies and careers? Future research and program approaches must continue to address these questions. Our research so far suggests that the strategies used in GCG help girls develop the ability, interest, and intention to be actively involved and persist in technology. They are developing both technical and social skills, as well as an increased reliance on themselves and peers to solve problems. Our research suggests that aspects of girls' self-identity (such as confidence) and social identity (whether others consider them to be good at computers) affect problem solving and their willingness to try new things. The approaches used in the Girls Creating Games program have the potential for increasing the number of girls who become producers, not simply users of technology, and research suggests that this is one key to their persistence with IT.

More research is needed in order to accurately assess the usefulness of the concept of intrepid exploration for addressing the gender gap in IT. For example, we need studies of mixed gender programs, and of computer usage during school. We also need studies that employ more user-friendly software, because Flash is challenging for novice users. To accurately assess the potential of these strategies for promoting intrepid exploration, the software must have a logical structure and clear tutorials or help options that contribute to successful problem solving. Future studies of intrepid exploration should also address whether a certain level of computer literacy is necessary before one can become an intrepid explorer.

Our model of intrepid exploration builds on our belief that statements about a "female style of computing" are off the mark. Two decades ago, Turkle (1984) described two styles of computing. One is a hard mastery approach that involves risk taking, where people test the limits of the machine and the self through objectification and manipulation of the computer. The second is a soft mastery or relational style, "marked by an artistic, almost tactile style of identification with computational objects, a desire to play with them." (p. 50). Turkle (1984) suggested that males are more likely to use a hard mastery style, and females a soft mastery style. As a result, many programmatic attempts to increase girls' participation in technology have wrongly assumed that there is a singular "female" style of computing. This has resulted in oversimplified ideas of what girls need to succeed in IT.

Recent research has begun to challenge these dichotomies (McKenna, 2001; Werner & Denner, 2005), and aspects of both these styles are present in our characterization of intrepid exploration. We hope that the use of this concept in future research and intervention programs will help break down simplistic notions of what girls need to succeed in IT. More research is also needed to determine whether the concept of intrepid exploration can help us go beyond gender dichotomies in our explanation of how people approach computing.

CONCLUSION

In order to increase the numbers of female intrepid explorers, it is important build girls' ability and motivation to explore, but also to change the culture of technology. The games created in GCG are one step in that direction, as they begin to redefine the content and experience of IT. In addition, learning environments that create a space for girls to produce (not just consume) technology help to build what Gee (2003) calls "affinity groups" which can reinforce girls' curiosity, creativity, and confidence. We hope that our definition of intrepid exploration, the five program strategies, and the preliminary research described in this article can provide a touchstone for the next generation of research and intervention programs.

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KEY TERMS

After School Program: A setting with activities where students voluntarily spend time.

Intrepid Explorer: One who is skilled, creative, and fearless about trying new things on the computer.

Learning Environments: Both school and non-school-based settings that influence how people interact with computers.

Middle School Girls: Female students who are in the sixth through eighth grades.

Participation in Technology: Being actively involved as a producer, not simply a consumer of technology.

Problem Solving: The steps one engages in to overcome a challenge or mistake.

Social Identity: How one wants to be seen by other people.

Zone of Proximal Development: The difference between what someone can do on their own, and what they can do with support from others.

The Glass Ceiling in IT

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INTRODUCTION

The term "glass ceiling," first coined in 1986, is a metaphor for "those artificial barriers based on attitudinal or organizational bias that prevent qualified individuals from advancing upward in their organization into management-level positions." (U.S. Department of Labor, 1991, p. 1).

In has been noted in a number of publications that information technology (IT) is a particularly enlightening field for the study of gender inequalities, such as the glass ceiling. For example, Ramsay (2000) noted that while inequalities in more established industries might be considered a historical leftover of obsolete gender stereotypes, the newness of computing presents researchers with the chance to examine how gender relations develop in an industry apparently less fettered by tradition. IT presents an exemplar case study for those who wished to examine "… whether the dynamics of disadvantage have their roots as deeply in today's employment settings …" (Ramsay, 2000, p. 215). Research indicates that IT has, however, developed to reflect precisely the same forms of gendered inequalities that have been documented in older industries (Suriya, 2003). The metaphor of the glass ceiling is equally applicable to IT. Panteli, Stack, and Ramsay (2001), in a comment on the United Kingdom (UK), which nonetheless resonates internationally, state, "The growth in IT should have opened up new possibilities for women to enter these occupations. However, its growth so far has been used to construct and maintain gender differences and to sustain male hierarchies" (p. 15).

FUTURE TRENDS

Although there has been some improvement in women's representation at the level of management in IT, women remain significantly underrepresented at this level (Panteli et al., 2001). As is the case in many other occupations, women tend to be concentrated in the lower echelons of IT. Suriya (2003) finds the same pattern replicated globally in her overview of gender issues in IT career development in the United States (U.S.), Canada, Brazil, UK, the Netherlands, Austrailia, India, and Malaysia. Millar and Jagger's (2001) report on the participation of women in ITEC employment in the UK, Canada, U.S., Ireland, Taiwan and Spain confirmed that in addition to being underrepresented in ITEC as a whole, "women in ITEC jobs generally appear to have lower status …" (p. 12). Worryingly they, like others, have found evidence of a decline in women's participation in ITEC jobs in recent years, Baroudi and Igbaria (1995) note the potential for severe shortages in the IS labor force, unless the participation rates of minorities, including women, are increased.

BACKGROUND

Explanations for the glass ceiling in IT have drawn upon a variety of disciplines, primarily sociology, psychology and economics.

Psychological explanations have traditionally focused on seeking differences to identify and explicate divergences in men and women's relationship to IT. However, explanations that focus solely upon psychological differences between men and women have been subject to criticism; it is perceived that they promote an essentialist view of gender, drawing on assumptions that there are inherent differences in men and women's aptitudes and motivations, for example (e.g., Trauth, Quesenberry, & Morgan, 2004). Adam, Howcroft, and Richardson (2004) argue that "the chain of reasoning from an 'essential' gendered characteristic to the prediction of some aspect of technology acceptance could be made quite differently if the more socially structured gender and technology research literature is taken into account" (p. 229).

Sociological explanations for the glass ceiling in IT have drawn primarily on social constructionism, a body of theories that emphasise the role of individuals in constructing reality through their interpretations of the social world. From this perspective, masculinity and femininity, their associated stereotypes and roles are held to be socially constructed rather than based on any biologically determined differences between the capabilities of women and men. For example, it is because we collectively *understand* IT to be a masculine domain and act upon this understanding that women face so many barriers to advancement within IT employment, rather than because there is necessarily any truth to this construction. Nielson, von Hellens, Beekhuyzen, and Trauth (2003) have also employed the renowned sociologist Anthony Gidden's structuration theory to understand women's experiences of barriers to advancement in IT.

Explanations for the glass ceiling in IT have also drawn on human capital theory to explain women's disproportionate lack of advancement within IT. At the risk of oversimplification, human capital theory, which originates from economics, holds that an individual's earnings will correlate to the value of their human capital; for example, their education and training. Baroudi and Igbaria (1995) examine the application of human capital theory to job outcomes for male and female information systems (IS) workers. Employing a sample of 348 IS workers, they found that their female participants were more likely than males to be employed in lower-level positions. The authors cite clear differences in the human capital of their male and female participants as an explanation, with women being younger and concomitantly less experienced, though equally well educated. However, the authors also conclude that the differences in men's and women's employment grade persist even when controlling for differences in human capital. They concede that the human capital theory cannot entirely justify their findings. Alternative explanations focus primarily on the untapped potential of training as an explanatory variable. Human capital theory has been subject to criticism from both economists and sociologists for its assumption of a purely rational labor market and insufficient consideration of the potential of system inequalities to explain discrepancies between individuals' measurable human capital and their earnings.

From the field of information sciences, Trauth et al. (2004) and Trauth, Quesenberry, and Yeo (2005) have developed the endogenous *Individual Differences Theory of Gender and IT*. In this approach, the overarching socio-cultural explanatory framework is protected from the potential for essentialism, through comprehensive treatment of the differences among and similarities between genders. The focus on the individual at the level of analysis seeks to prevent predilections towards dualism and provide greater opportunities for the identification of negative cases and individual agency, while retaining a focus on social rather than individualist explanations. Wright (1996), a sociologist, has also proposed the *Controlled Progress Theory* for the specific purpose of interpreting trends in women's participation in IT. This theory seeks to merge Kanter's *Tokenism* and Jacob's *Social Control* theories. Wright (1996) holds that while it has become easier for women to enter IT occupations, the related organizational culture is a factor in their higher exit rates compared to males.

KEY CONTRIBUTING FORCES

Direct Discrimination

Direct discrimination unquestionably remains a feature of women's experiences of employment. Even in countries where greater legislative protections and increased awareness regarding the illegality of discrimination on the grounds of gender have impacted the significance of direct discrimination to women's advancement, government authorities still record cases of sex discrimination in employment annually, including in relation to promotion. However, recent academic research has been much more focused on what are considered to be even more pervasive, less readily identifiable, less easily actionable sources of disadvantage to women, such as those that emanate from stereotyped assumptions about differences between men and women, prevalent in the organisational and wider cultural contexts.

Masculine Organisational Culture

Feminists have highlighted masculine organizational culture as an explanation for the glass ceiling.

O'Connor (1999) explains that the concept of organisational culture is typically used to refer to "the existence and importance of a complicated fabric of management myths and values that legitimate women's positions at the lower levels of the hierarchy; portray managerial jobs as primarily masculine; define women as unfit for managerial positions, etc." (pp. 229-230). Masculine organisational cultures can isolate and exclude women through devaluing feminine work styles, limiting women's access to informal social networks and mentoring, presenting exclusively masculine "mental models" of management and eroding women's self-confidence through the dominance of male-culture behaviors.

Panteli et al. (2001) hold that masculine organisational culture is a significant barrier to gender equality in IT and that IT companies are particularly likely to be strongly masculine. Roldan, Soe, and Yakura (2004) suggest that the influence of engineering on IT helps to explain the existence of a male-dominated culture in such a new occupational area. They note that "… a culture that develops in a male-dominated environment is necessarily one in which males have the advantage" (p. 110).

Work Styles

Working within a masculine organisational culture, women find themselves caught in a double bind. Work styles perceived as feminine—for example, cooperation and consensus-based practice—are not valued as highly as those viewed as masculine. Women who practice (or perform) feminine work styles, therefore, will be less valued than their male counterparts practicing masculine work styles. Indeed, Panteli et al. (2001) argue that they will be seen as "less confident and capable" (p. 11). On the other hand, women who try to perform masculine work styles will be punished for not conforming to gender stereotypes and will be seen as aggressive (Sumner & Werner, 2001). Lemons and Parzinger (2001) view an unwillingness to accept a diversity of management skills as a significant barrier to women's advancement in IT.

"Old Boys' Network"

Employees have a tendency to "cluster with others like themselves" (Panteli et al., 2001, p. 11). In male-dominated environments or, as is common, where males disproportionately occupy positions of power, this propensity disadvantages women, reducing their access to highly advantageous social networks, including influential social ties and informal channels of communication that can provide access to information on promotional prospects, for example (e.g., Tierney, 1995; Nielson et al., 2003). Hemenway (1995) notes that access to information from people other than one's direct supervisor is important to gaining a breadth of knowledge and understanding of technical, cultural, political and organisational issues relevant to one's work environment. She relates that social networks can also lead to informal mentoring and raise one's profile with one's superiors, both of which promote advancement. Baroudi and Igbaria (1995) found, however, that among their sample of IS workers, women had much more limited social networks within an organisational context than men and were less likely to mix with people outside of their own department. Sumner et al. (2001), in their study of MIS graduates, found that informal networking facilitated male participants' lateral career moves, but female participants had not benefited from this resource.

Mental Models

A mental model refers to the mental picture we conjure when we try to imagine a situation or position. Resulting from our socialisation into gender stereotypes, when we picture an individual in a position of authority, our mental model for the person occupying that role is more often that of a man. Commonly held gender stereotypes associate masculinity, rather than femininity, with authority. Roldan et al. (2004) note that studies have shown that males in particular do not associate perceived feminine characteristics as relevant to management.

Hemenway (1995, p. 57) extends the lack of association between femininity and positions of authority to professionals generally, particularly in science and engineering. She states that "… you generalize based on the similarities and differences among the examples you know. Although intellectually you may know that things like gender and race are irrelevant, that knowledge does not stop your mind from implicitly generalizing based on similarities in those irrelevant features." These kinds of generalisations can also impact how we think about our own potential to become a member of stereotypically dissimilar groups.

Male-Culture Behaviors

In situations where the organisational culture tends to favor masculinity, male-culture behaviors can predominate (Hemenway, 1995). Such behaviors may impact on women in a variety of ways, ranging from feelings of isolation to intimidation and harassment. Hemenway (1995) cites as constituting male-culture behaviours "remarks that devalue women; bullying; sexist jokes; locker-room-caliber conversation; a focus on male-oriented activities and widespread use of metaphors from these activities; display of images either on walls or computer monitors that portray women as sex objects or otherwise devalue them" (p. 58). Panteli et al. (2001) note that male-culture behaviours can be a significant factor in "eroding women's self-confidence and ability to present themselves successfully."

Caring

As with perceptions of correlations between masculinity and authority, women's traditional association with the primary responsibility for care giving, particularly for providing childcare in the family, is a function of socially constructed gender roles. Women can experience significant social pressure to fulfil traditional role expectations with regard to child rearing and child bearing. It is now much more common to combine motherhood and a career outside the home; however, women often find that this results in a double day—that is, they must fit two jobs into their day, that of mother and paid worker. Women's disproportionate role in childcare provision makes juggling these demands particularly difficult. Mather Saul (2003) argues that the assumption that workers are free from childcare responsibilities, inherent in the structuring of work, is further evidence of the gendered distribution of power in society. "… the structure of jobs may be biased against women even if nobody has ever worked consciously towards that goal" (Mather Saul, 2003, p. 12).

Although the IT industry is associated with innovations that facilitate the combination of paid work and childcare, such as teleworking and telecommuting, Roldan et al. (2004) note that the balancing act that many women perform between work and primary parenting is still a widely accepted factor in gender inequalities in IT. They add that IT may be a particularly difficult environment in which to balance paid work and childcare responsibilities, citing extended work schedules and the expectations that IT personnel will (want to) commit leisure time to keeping current with new technological developments. Mather Saul (2003) notes that employees who take up flexible working arrangements experience negative impacts on their advancement. It is worth noting that Igbaria, Parasuramank, and Greenhaus (1997) found that women in IT were less likely to marry than men and less likely than men to have children when they married.

Family-friendly work environments, including flexible time arrangements, public and privately supported childcare and, more fundamentally, alterations to social constructions of the "ideal worker" and primary caregiver, are all key to reducing the negative impacts of motherhood on women's advancement.

The Wider Cultural Environment

Emphasising that social constructions of gender are never fixed, but constantly being reproduced and remolded, Trauth et al. (2005) note the existence of regional variations, possibly reflecting a rural/urban

Table 1. Positive actions

Hemenway (1995, p. 59-60) provides a useful overview of key "counterforces" that those working in IT can employ to help shatter the glass ceiling. These include:

- Education and awareness-raising regarding invisible barriers to women's promotion, including mental models and male-culture behaviours, for example
- Developing systematic techniques for identifying and evaluating candidates for promotion to prevent bias
- Perform gender audits
- Provide more female role models and mentors for women
- Reward actions that promote diversity within your organisation; for example, becoming a mentor
- Facilitate the reporting of gender-biased behaviours and sexual harassment through the provision of employee advocates, such as an ombudsperson.

divide, in the exposure of women to traditional gendered stereotypes. Earlier studies emphasised supranational variations in the constructions of gender impacting on women's advancement in IT, with emigrants from former Soviet republics relating much more self-assuredly gender-neutral mental models of the IT worker/engineer (Trauth, 2003). Roldan et al. (2004) term the wider cultural context within which organisations operate "feeder" cultures, emphasising the potential for geographical variations in culture to differently influence organisational contexts.

CONCLUSION

Many authors are highly critical of what they term "add women and stir" (e.g., Suriya, 2003; Panteli et al., 2001) solutions to the existence of a glass ceiling in IT. Such approaches advocate more equitable access to opportunities and resources (e.g., to IT education and training) as the solution to gender inequalities. While such reforms are certainly part of a broader solution to women's under representation in IT management, much of the work currently being undertaken in relation to the glass ceiling in IT emphasises that barriers to women's advancement are much more systemic and fundamental.

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KEY TERMS

Direct Discrimination: Direct discrimination occurs when a person is treated less favorably on the basis of invidious grounds, such as gender, age, race, disability, sexual orientation or religion.

Feminism: A social movement that seeks women's rights and social, political and economic equality among men and women. Feminism has produced diverse theories and philosophies oriented to understanding women's experiences.

Gender Roles: Gender roles set down the different behaviors and expectations socially constructed as appropriate to men and women.

Glass Ceiling: Metaphor for the barriers to promotion experienced by women. The utility of this concept has led to its use to describe the obstacles to advancement experienced by other minorities.

Human Capital Theory: Human capital theory holds that an individual's earnings will correlate to the value of their human capital; for example, their education and training.

Social Constructionism: A body of theories that emphasise the role of individuals in constructing reality through their interpretations of the social world.

Structuration Theory: A theory developed by sociologist Anthony Giddens that seeks to overcome the dichotomy between action and structure.

Government and Corporate Initiatives for Indian Women in IT

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INTRODUCTION

Education of women severely lags behind that of men in many developing nations. Fewer girls go to school, tend to drop out earlier than boys, do not receive the same level of education as their male counterparts, and often choose careers that are female predominant (Kelly, 1987). Without exception, India is quite representative of these gender-biased phenomena in education. However, the recent explosion of offshore outsourcing market in India has created a new recognition regarding the role of women in technological careers. The Indian IT sector has seen a trend contrary to what most western nations are experiencing—predominance of women in IT, particularly in IT-enabled services (ITES).

India has acknowledged that extensive and intensive use of information and communications technologies (ICT) alone can help the nation develop its neglected human resources, emerge as a knowledge-based society, and participate competitively in the global trade and services. Consequently, the development of ICT has become a national issue with strong impetus from the union government in New Delhi (Choudhary, 1999). Explicit in this initiative is the recognition that to progress as an information society, women must be empowered as key players the IT sector. In parallel, two other trends have focused attention on women in the information society—a nationwide movement for women's rights spearheaded by many non-government organizations (NGOs) and an increased awareness of corporate social responsibility. Consequently, over the last decade, there has been an increased emphasis on education and reskilling India's female workforce. While many government efforts are targeted toward the overall upliftment of women, many grassroots level initiatives led by NGO's and corporations emphasize technological training.

This article highlights how the intertwining of grassroots and policy level efforts can increase the pace at which a nation's female workforce can be reskilled and prepared for a technological world. The article also addresses concerns about such rapid development and potentially challenging outcomes while making recommendations for improvement.

BACKGROUND

In many contexts, India is a representation of paradoxes. Over 44% of India's population is below the poverty line, its per capita income is under $100, and adult literacy rate is about 44.3%. Yet, the Indian education system churns out young minds that have excellent training in math, science, and technology (MST). While only 25% of India's urban population and 1.5% of its rural population has access to telephones, India boasts of one of the fastest growing software industries in the world.

The role of women in the Indian society remains similarly paradoxical. India was one of the first countries to give voting rights to women subsequent to emancipation from British rule in 1947 (UNESCO, 2002). The country was led by a woman prime minister for several decades, a rarity on a global scale. Religious scriptures lay particular emphasis on the power of the woman to enable a progressive society. However, while the Indian constitution grants many legal rights to women, the socio-economic status of women still seriously lags behind that of men.

There has been no dearth of government initiatives in India in the past to promote equalization of gender roles. Yet some of the most meaningful schemes have emerged only in recent years for several reasons: the IT sector has experienced rapid growth due to global sourcing, monetary compensations for IT related positions have increased dramatically, and many NGOs, women's organizations, and corporations have become more radically involved in female participation to leverage these trends. The next few sections examine the role of these entities in the advancement of women in the IT sector.

MAIN THRUST

The function of government in India's workforce development reflects a trend that has been observed in many western nations where the government has gradually withdrawn from the direct delivery of many programs and has increasingly relied on non-profit organizations to take on this role (Zappala, 2000). NGO's and corporations have stepped in to implement and deliver government policies for improvement of education and working conditions.

Government: An Overall Emphasis on Girls and Women

Governments in many developing countries, including India, have been instrumental in providing funding for IT education and training to encourage everyone, not just women, to become technically sophisticated. Women have, however, seized these opportunities willingly because IT work presents an opportunity for women to compete with men cerebrally—rather than physically (Sneddon, 2004). One such initiative in recent years has been making education pervasive in all households. While not an IT initiative, the most common educational policies and goals are not intended to help one group of users more than any others (Klein, 1987). In year 2000, the government initiated a $250 million national program with the objective of enrolling all children between 6-14 years of age in the educational system by 2010 (UNESCO, 2004). Subsets of this program, National Program for the Education of Girls at the Elementary Level (NPEGEL) and Kasturba Gandhi Swantantra Vidyalay (KGSV) focus on bringing girls into the education stream. This program is aimed at developing model elementary schools in 21 states with an emphasis on providing benefits for underprivileged and under represented girls in education. This is a start to overcoming one of the most serious barriers to representation of women in the workforce in India—increased and improved education for girls. As a part of these umbrella reforms in the Indian educational infrastructure, the government has established proactive policies for girls' enrolment in science, engineering, and technology (SET) courses. Computer literacy excellence awards for schools that demonstrate promotion of technological education have been initiated to encourage schools and colleges to examine and improve their IT curricula.

The residual effects of widespread women's movements are evident in the declaration of Year 2001 as the "Women Empowerment Year." While the general objective of this initiative was to provide self-awareness and generate an environment conducive to development of self-confidence and assertiveness among women, a significant portion of this initiative was devoted to women in technology. Specifically, some plans related to:

- Establishment of technology parks
- National assessment of technology drudgery reduction, tools and implements income generation for women
- A traveling exhibition of women in MST

The establishment of the Ministry of Communications and Information Technology (MIT) has provided a significant impetus to the development of India's IT workforce. The multitude of projects undertaken by this ministry includes:

- Establishment of a task force with the intent of setting up a long-term strategy for development of a strong IT workforce
- Provision of employment oriented training for educated youth to meet the shortage of trained IT professionals
- Development of curricula in cyber security and IT systems management
- Setting up ERNET, a network for academic and research institutions

The ministry has also instituted the "IT Super Power Group" to promote improvement of IT workforce whose immediate concern is to address issues regarding women in technology and technology development in rural areas. While MIT has been actively involved in the development of broad policy initiatives, many of these are filtering down to women through NGO's and corporations.

Government Support for Higher Education and Training Initiatives in Technology

Recognizing that implementation of many programs must occur from the grassroots, specifically educational institutions and other non-academic training institutes, the government of India began providing more support to private institutions and colleges that impart technology training. The recent establishment of the Department of Education Accreditation of Computer Courses (DOEACC) has enabled accreditation of educational institutions on their technology course offerings (DDSI, 2002). This division of the MIT provides accreditation at four levels—from diploma and certification to MS programs. The government also has plans for Indian Institutes of Technology Management (IITM) modeled after the prestigious Indian Institutes of Technology (IIT) that have produced talented workforce in MST for decades. IITM is expected to continue this effort with focused attention on IT workforce development.

Improving Working Conditions for Women in Technology

Outsourcing from the western countries has posed a unique demand on the Indian workforce. IT service providers must now work in 24-hour shifts to complement working hours of their western clients. Women desiring to leverage growth in the IT sector must adapt to these new requirements. Since corporations were not under mandate to provide conducive working environments for women, these long and awkward hours of IT work were discouraging.

In recent years, however, working conditions for women in IT have received much attention from state and federal governments. Of particular interest is the State of Karnataka, home of India's Silicon Valley—Bangalore. Karnataka has instituted policies that require at least five women to be employed during night shift in an IT company, free transportation to and from home, adequate number of women security guards on the premises, privacy for women employees, and provision of day-care facilities for children under the age of six. Similar initiatives have been instituted by the city of Chandigarh, which requires sufficient security and transportation for all women between 18-21 working on night shift in ITES industries. While such policies are not pervasive in India yet, the government's role in rapid policy creation and of corporations in policy implementation has been encouraging.

Women IT Entrepreneurs

With 65% representation, ITES represents a successful sector for women in India. Much of this success can be attributed to involvement of women from lower income strata in setting up IT entrepreneurships. Several government initiatives have been focusing on promoting technology development in rural India with particular emphasis on promoting women IT entrepreneurs. Mother Teresa Women's University has initiated new courses for promoting high-tech professional entrepreneurship among women. These courses are offered in conjunction with the University Grants Commission (UGC), the only educational grant giving institution in India. The government has also empowered certain banks to provide liberal loans conditions such as reduced interest rate and relaxed margins for women.

Non-Government Organizations

In an attempt to harness the forces of rural and low-income populations in India, several programs train and educate underprivileged women in IT. One such example is World Bank's *SITA* (Studies in Information Technology Applications) program for low income and socially underprivileged women, which is part of a larger initiative for gender empowerment. About 507 women from families with incomes less than $60 were given free intensive hands-on computer training based on real life exercises using MS Office 2000. Some trainees were attached to a potential employer. Trainees were required to offer part-time services as an assistant Trainer, after completing her course in order to provide confidence required in the workplace. *MitraMandal*, a co-operative enterprise has furthered *SITA* by continuing to train women from low-income families (Sane, 2001)

India's National Institute of Information Technology (NIIT) was formed in 1981 with the intention of providing certificate training in information technology. Recognizing the alarming trend of low female representation in their own curriculum as well as in the U.S., NIIT's recent ventures provide basic technology education for women and children. In particular, two initiatives have particularly been focused in this direction—*Hole in the Wall* and *Swift Jyoti*. The former program provides training to children in technology while developing their ability to self-train in technology. The *Swift Jyoti* program was designed with the intention of "bringing 50,000 women and computers together." This low cost ($15), three-week program provides functional computer literacy for women in four languages. NIIT recently provided free training to 5000 teachers and principals. Another program initiated by the organization is *BOOT IT*, a television-based distance-learning project, to bring computer education free to the homes of millions of Indians. In an attempt to bring awareness to these issues, NIIT has launched programs such as World Computer Literacy Day and International Women's Month (NASSCOM, 2003).

Industrial Partnerships

Many corporations are beginning to recognize, as a part of their social responsibilities, the need to provide technical education to underprivileged girls. Examples of such organizations are vMoksha and Xansa. vMoksha has partnered with *Navjaeevna*, a home for underprivileged girls, to provide basic computer knowledge and awareness of the relevance of computer education. To initiate the program, vMoksha donated computers and employed a teacher to give the girls a basic IT education.

Corporations such as Xansa have recognized through their IT initiatives that corporate social responsibilities must extend beyond the provision of IT education. Xansa, a UK based IT outsourcing firm, has consciously been involved in the development of IT workforce through support for underprivileged sections of the Indian population. It initially adopted schools and villages with the intention of providing basic computer education. However, it soon recognized that that lack of basic amenities such as water, clean and hygienic environments, and education were a greater bane for these schools and villages and has subsequently partnered with other social institutions such as *Pratham* to better provide these amenities to schools and villages.

Realizing the important role of technology in adult education and job training, IBM has set up the Gandhi Institute of Computer and Information Technology, in partnership with the Bharatiya Vidya Bhawan. This institute provides free computer education to students from the economically weaker sections of society. IBM has donated PCs and other equipment to open a computer center for imparting training to the visually impaired students of the Victoria Memorial School for the Blind in Mumbai. IBM has also extended its computer camps for middle-school girls, EXITE (Exploring Interest in Technology and Engineering), to India. In this program, girls receive hands-on experience and support, while learning how to break down and rebuild computers, construct web sites, build and program a Lego robot, and develop presentations among other tasks. The goal is to encourage girls' interest in MST and provide an in-depth look at career opportunities in the field of technology (IBM, 2005).

India's leading outsourcing provider, Tata Consultancy Services (TCS) has developed computerized programs to address the adult literacy problem in India. The company has undertaken adult education projects in many states. Microsoft has committed to the provision of academic software worth $1 million for five years to children studying in various schools in the country with the intent of providing basic software training in MS Office, Visual Basic, and other common software packages. These applications are being provided to public schools that typically do not have funds to obtain such resources. With a strong belief that India's educational system need to be strengthened, Polaris has set up "Ullas" trust, which gives monetary aid to students who cannot afford education on their own. It is also providing them free computer training at its office premises. Many of these corporations such as Infosys, TCS, and Polaris are also providing volunteer time and funds for promotion of general welfare of women and children and have subsumed technological training under this larger initiative.

CONCLUSION

Due to recency of many initiatives described above, complete and valid data is not available to describe the success of many of these ventures. Statistics indicate that increasing number of women are entering the IT workforce at various professional levels, that increased entrepreneurship initiatives in the form of cybercafe's as been on the rise, and that internet is now available in many rural areas. Suggestive of successful policy and grassroots level initiatives, these trends are encouraging since they represent a multi-faceted approach to a basic problem more prevalent in the underprivileged sections of the population—women and children. Many of the educational initiatives are encouraging since they promote IT education as a part of an overall improvement in the curriculum. However, the progress must be continuous and progressive and not just in response to market demands.

At a lower level, are the corporate and NGO initiatives with regard to computer technology as successful? Many of these programs are attempting to provide IT education to women from underprivileged backgrounds. Often these women have minimal or no education and are more socially constrained than those from more affluent environments. These constraints can reduce the potential of meaningful employment subsequent to a basic computer education. An example of such an initiative is the efforts of the *SITA* project described above. This project, though successful in training many women from low-income groups, did not result in meaningful employment for an estimated 70-trained women. The demoralizing outcome of this project resulted in its collapse in December 2000.

While these initiatives may enable underprivileged women to rise from their current vicious circle of poverty and lack of opportunities, they also run the risk of continuing to promote routine, low skill, and low paying IT initiatives for women while retaining the higher skilled jobs for men who already benefit from greater access to higher education and better training. As Hafkin and Taggert (2001) suggest, the provision of basic education and training for women must be improved in order for them to obtain the true benefit of globalization and IT growth. For this, policies that ensure IT education in early years and increased higher education for women must be effectively implemented before benefits of IT training can be achieved.

Obstacles faced by women in homes and work environments must be reduced for beneficial outcomes (Gurumurthy, 2004). New forms of these impediments, ironically often promoted through the use of ICTs, must also be recognized and eradicated in its nascency. For instance, a study by the International Labor Organization reports that 3 out of 4 call center workers face repeated sexual harassment over the phone (ILO, 2001). Similarly, promotion of pornography via internet is another looming threat to the equalization of female work conditions in many of these countries.

Results of many initiatives discussed above will be slow in emerging. A micro level improvement in women's education, social, and economic infrastructures must emerge in order for the true benefits of these initiatives to set in. This may take a few decades. However, the increased recognition of women in the workforce by the government, and a grassroots level effort by NGOs and corporations appears to be the right strategy for bringing rapid changes for female representation in IT. For researchers, India provides a unique opportunity to examine issues related to upliftment of women in a specific sector. In stark contrast to the gradual development of IT sector in most developed nations, India's rapidly expanding IT sector poses unique challenges and opportunities that are ripe for examination in research settings.

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KEY TERMS

DOEACC: Department of Education Accreditation of Computer Courses, an autonomous division of the Indian Department of Information Technology tasked with the accreditation of computer courses—http://www.doeacc.org.in/

ERNET: Education and Research Network, a project initiated by Indian Ministry of Communications and Information Technology that has undertaken the establishment of a national network to support research and development in educational institutions—http://www.mit.gov.in/hrd/ernet.asp

MIT: The Ministry of Communication and Information Technology formed by the Indian government to oversee and direct the design, development, and management of technological education and progress in India—http://www.mit.gov.in/

NPEGEL: The National Program for the Education of Girls at the Elementary Level intended to improve the educational conditions of women and girls in India with special emphasis on technological training.

UGC: University Grants Commission, a government organization with two broad level functions, providing funds to Indian educational institutions and coordination, determination, and maintenance of standards in institutions of higher education—http://www.ugc.ac.in/

Health Portals and Menu-Driven Identities

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INTRODUCTION

In this article, we make a case for research which examines the cultural inclusiveness and salience of health portals. We make our case from the standpoint of African-American women. While healthcare should be a ubiquitous social good, health disparities exist among various demographic groups. In fact, health disparities have been placed on the U.S. disease prevention and health promotion agenda. *Healthy People 2010* is an initiative sponsored by policy makers, researchers, medical centers, managed care organizations, and advocacy groups across the country. Although there is no consensus regarding what a health disparity is, sponsors agree that "racial and ethnic minorities experience multiple barriers to accessing healthcare, including not having health insurance, not having a usual source of care, location of providers, lack of transportation, lack of child care, and other factors. A growing body of evidence shows that racial and ethnic disparities in health outcomes, healthcare access, and quality of care exist even when insurance, income, and other access-related factors are controlled."[1]

In addition to healthcare, African American women have less access to the internet. Even at equivalent income levels, African Americans are less likely than either whites or English speaking Hispanics to go online. Demographically, the composition of populations not online has not changed dramatically since 2000. Overall, 60% of the total U.S. population is online with African Americans making up 11% of the total U.S. population, 8% of the online population, and 14% of the offline population. However, when looking at those who are offline, African Americans are more likely than offline whites or Hispanics to believe that they will eventually go online (Lenhart, 2003).

Although online health information is available from multiple sources, we focus solely on those health portals sponsored by the U.S. government. We made this choice based upon some early interviews with physicians and managers at a healthcare facility which serves predominantly African American clients. We learned that most clients exhibited a low degree of trust in information provided by pharmaceutical companies and other sources which seemed too commercial. Instead, clients searched for information from recognizable sources, and tended to use portals and search pages like Yahoo and Google. We found that portals sponsored by U.S. government agencies were received positively by clients. Also, portals like healthfinder.gov and cdc.gov are highly regarded by the Medical Library Association[2]. Moreover, the government is entrusted to uphold values of democracy and social justice therefore the health information that they provide should be accessible to a demographically diverse audience.

To gain insights into the cultural inclusiveness and salience of health portals, we use Nakumura's notion of menu-driven identities. For Nakumara (2002), the internet is a discursive place in which identity is enacted. She uses the term "menu-driven identities" to signify the ways in which content providers represent identities through the design of the interface and the personalization of content, and users perform their identity as they engage with the content. In what follows, we discuss health disparities and the promise of the internet in redressing inequities. Next, we further explain the ways in which users perform identity and health portals represent identities. We do this by theorizing about the health portals as mediating two-way communication between users and information providers. We conclude with directions for future research.

BACKGROUND

Health portals hold promise as an informational source for improving the health of historically underserved populations. This promise is extremely exciting given the state of health disparities in the U.S. We know from prior studies that health provider bias, stereotyping, prejudice, and clinical uncertainty may contribute to disparities along the lines of gender, class, race, and ethnicity (Balsa & McGuire, 2003). For instance, in a study by Bird and Bogart (2001), 63% of survey participants indicated that they had experienced discrimination in their interactions with their healthcare provider because of their race or ethnicity. Similarly, African Americans interviewees reported perceived discriminatory experiences such as inferior treatment, negative attitudes, being treated as if they were unintelligent, being ignored, inappropriate allegations, and racist remarks (Hobson, 2001). These negative experiences may profoundly impact attitudes towards receiving care, and willingness to comply with physician recommendations. For example, Hobson (2001) found that nearly 27% of African American survey respondents reported that, as a result of a discriminatory event, they were more hesitant to seek health services. Others avoided the healthcare facility (25.6%), avoided the provider (23.1%), avoided the personnel involved (10.3%), stopped using specific services (15.4%), or used service less frequently (7.7%).

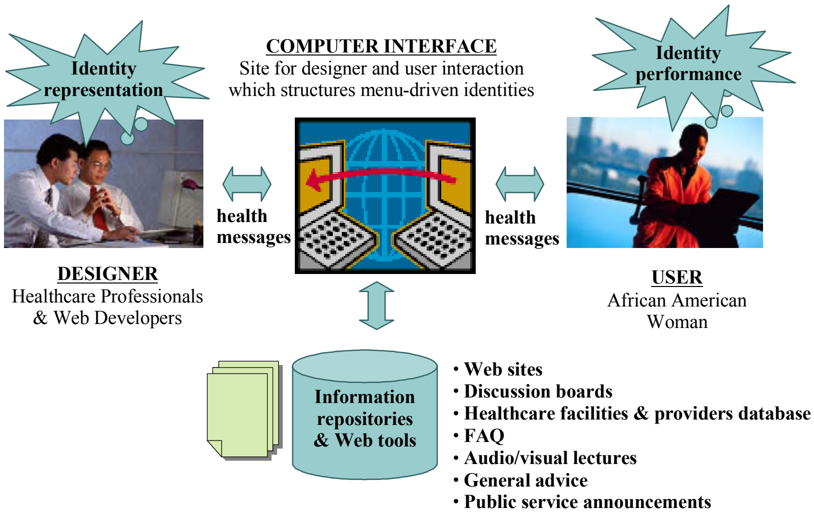
Computer mediated communication may help minorities, women and other underserved groups to receive healthcare information in a more hospitable climate. The popularity of the internet as a medium for health communication is evidenced in two ways. First, the number of health-related Web sites has dramatically increased from a mere 15,000 sites in 1999 (Rice, 2001) to 100,000 as of 2003 (Cates, 2003). Secondly, although these sources vary in quality and relevance, the number of people seeking online health information rose to 97 million in 2001 from 60 million in 1999 (Rimal & Adkins, 2003). In a 2002 national survey (see Figure 2), researchers found that 73 million people in the U.S. or 62% of internet users have gone online to search for health information. On a typical day, about 6 million Americans go online for medical advice. This exceeds the number of Americans who actually visit health professionals according to figures provided by the American Medical Association (Fox & Rainie, 2002). And while 42% of Americans say they don't use the internet, many of them either have been internet users at one time or have a once-removed relationship with the internet through family or household members. In fact, some exploit workarounds that allow them to use the internet by having email sent and received by online family members and by having others in their home do online searches for information they want (Lenhart, 2003). Women are more likely than men to say their latest search was at least in part for someone else—62% compared to 50% of men. Women are also more likely than men to seek healthcare and health information both online and offline (Fox & Fallows, 2003).

Identity

As an increasing number of Americans obtain health-related information online, it is important to consider that the internet is not race and gender neutral. Rather, it is a discursive space in which identities can be represented, performed, swapped, bought, sold, and stolen. Users can create profiles to personalize their experience, and create avatars which serve as visual representations of the body in cyberspace. But while spaces for fluid subjectivity abound, the internet often fails to accommodate minority cultural identities (Kolko, Nakamura, & Rodman, 2000; Kvasny, forthcoming).

Identities are inextricable from communication and are enacted in messages (Hecht, 1993). These enactments transmit and exchange values, beliefs, and norms, which may or may not affirm individuals' or groups' understandings of their own identities (Jackson, Warren, Pitts, & Wilson, under review). Identities also act as interpretative frames in the communication process (Hecht, 1993). Messages are filtered through and made sense of in relation to how individuals perceive themselves. If health messages communicate an identity, which is in conflict with how African American women perceive themselves, then the information may be viewed as unusable and we have done little to combat health disparities. As with all communication, messages that diverge from the identities of minority populations are unlikely to prove effective. Hence, health information must be situated within the target audi-

Figure 1. Menu-driven identities



ences' sphere of experiences and understandings, or they may go unheeded.

When users search and consume information online, they perform identity. In fact, identity is the first thing that you do (create a profile or user account) before you can perform any activity. Identity performance is often a practical necessity constructed by designers who create the interface. Nakumara (2002) uses the term "architecture of belief" to signify how designers, through their choice of keywords, images, and use of language, create interfaces which represent the identities of some idealized user population(s). The interface reflects the cultural imagination of the designer, and performs familiar versions of race, gender, sexual orientation, and class. The relation between the user and the interface has been termed "menu-driven identity" performance and representation (see Figure 1) (Nakumara, 2002).

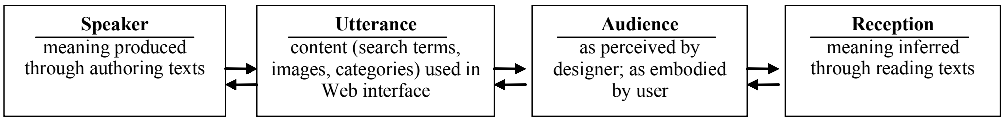
Thus, contrary to the popular notion that physical characteristics are erased online, the fact that Web users must reveal aspects of their identity suggests that bodies are often "outed" in cyberspace. For instance, we often have to define our race, gender, age, weight, marital status, and other identity factors when using health portals. In a cultural sphere such as health, these aspects of identity are crucially important factors to be considered, not superficial characteristics to be erased. Consequently, identity is not entirely fluid and physical bodies remain important even though they are largely hidden.

Health Portals

Health portals are made spaces in which identities are enacted through computer mediating conversations between users and designers. The interface serves as a site for the production, representation, distribution, and reception of texts (health messages) which convey meanings that affects relations of power. The distinctive rhetorical conditions of the speaker, utterance, audience, and reception are created as the designer and user co-create a communicative situation in cyberspace (see Figure 2).

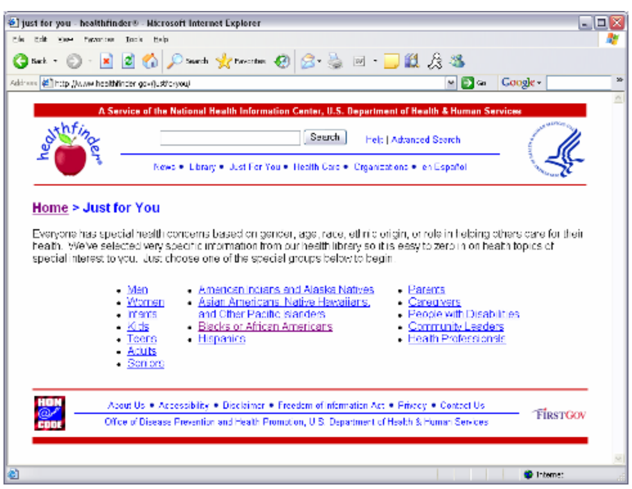
In what follows, we demonstrate how menu-driven identities are produced on two government Web sites. The first example is taken from the U.S. Department of Health and Human Services healthfinder portal—http://www.healthfinder.gov/justforyou/ (see Figure 3). The navigation scheme tends to reflect the unspoken biases and categories imposed by the more privileged actor (the government sponsor) in the communicative situation. Users must select an identity which is limited to two gender categories, four age categories, four ethnic/racial categories, and five roles.

Figure 2. Communicative situations



For African American women, predefined categories force the performance of race and gender in ways that marginalize, and in some cases deny, their existence. This occurs when there is limited space for identity expression because the categories reproduce the limited number of choices based on historical labels and ideologies around race, gender, age, and role. Health portals, therefore, become another discursive field in which African American women are rendered invisible because they are assumed to be only African American or female—multiple selections are not allowed because there are no categories which capture both race and gender. Other underserved groups, such as gays and lesbians, are rendered completely invisible because they have no category. White is also omitted from the choices, but this is because whiteness is assumed as the default category and simply goes without saying. These familiar versions of identity are scripted and ascribed by designers when they create interfaces based upon these types of simplified categorizations. Notice how the author "selected very specific information from our library so that it is easy to zero in on health topics of special interest to you. Just choose one of the special groups below."

Figure 3. Healthfinder[3]

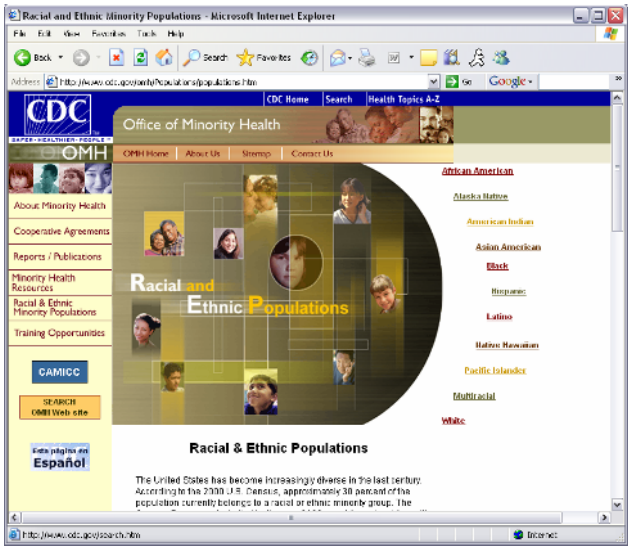


This example demonstrates how Web portals may serve as platforms for reproducing simplified discourse around difference. Category schemes are not simply passive tools through which labeling takes place, but rather are the outcomes of practices of meaning making. Designers of classification schemes constantly have to decide what categories are important, and in doing so, they develop an economy of knowledge that articulates omissions and inclusions, and ensures that only relevant features are classified (Bowker & Star, 1999). In doing so, health portals limit choices and the full participation of people who exist at the margins because users can only take the paths prescribed by the interface.

A second Web site taken from the Center for Disease Control, Office of Minority Health—http://www.cdc.gov/omh/Populations/populations.htm (see Figure 4)—demonstrates the instability of categories. For instance, race is an unstable signifier, which is socially constructed in dissimilar ways in various cultures. Blacks in the U.S. include all (including mixed race) people who trace their ancestry to Africa, but Blacks in South Africa don't include people of mixed African and European ancestry. In Britain, Black includes people with ancestry to non-African parts of the former empire such as Pakistan and China (Kolko, Nakamura, & Rodman, 2000). Racial signifiers are also unstable because they change over time. In the U.S., for example, people of African ancestry have been labeled Negro, Black, and African American.

In this health portal, the categories have been expanded to include white. Multicultural Americans are included even though it is difficult to make generalizations about health conditions because little research exists about this group. On the surface, it looks as though African American is treated as an

Figure 4. The center for disease control



ethnic marker distinct from Black, a racial category which would include people throughout the African Diaspora. However, when selected, each category is linked to the same Web page. Hispanic and Latino are also listed as two distinct categories which, when clicked, send the user to a single Web page.

FUTURE TRENDS

Given the increasingly diverse populations of internet users and the growing usage of eHealth resources, we pose several important questions for future research:

1. How are underserved groups socially constructed on health portals?
2. What do these social constructions suggest about inclusiveness and health disparities?
3. What types of information do members of underserved groups seek, and why?
4. How well do existing government health portals serve the needs of underserved population?
5. How might we design more inclusive information resources?

We also suggest that existing health portals could better serve the needs of underserved groups. While we cannot account for the accuracy of the information provided through these portals, we did observe a wealth of information that is pertinent to various demographic groups. The challenge that we raise in this article is how best to tailor user interfaces to improve the online experiences of culturally diverse users. A tailored user interface would include:

- A mixture of media formats including texts, audio, video, and slide presentations. Images should be representative of diverse people. Single page checklists, fact sheets, and brochures may be especially useful for women who are obtaining information for other family members and friends.
- Texts that are comprehensible by low-literacy users and availability in languages other than English.
- The ability to select multiple identities. This could be done with checklists or a menu structure that enables users to drill down through several demographic categories. For instance, a middle aged African American women could select from the *gender, race/ethnicity, age* categories to refine her information.
- Normative categories such as white and heterosexual should be listed explicitly.
- The ability to declare identities in ways that go beyond demographics. For instance status such as smoker, diabetic, HIV positive, and cancer survivor are important components of identity that influence health care needs and outcomes
- Spaces such as chat rooms and forums for users to act as speakers and authors in the communicative situation.

CONCLUSION

The internet offers a space where African American women and other underserved groups can become empowered health consumers who access health information on their own terms (Ferguson, 1997). However, it is important to understand the extent to which online health information is inclusive of diverse users. Providing computers and internet access, and showing underserved groups the value proposition of online health resources are simply not enough. We must also consider the cultural salience of content and inclusiveness of the interface design.

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KEY TERMS

Digital Divide: The term "digital divide" describes the fact that there exist people who do and people who don't have access to—and the capability to use—modern information technology, such as the telephone, television, or the internet. Access to these resources follows along demographic lines such as gender, income, race, ethnicity, geography, and age.

Health Disparity: Some demographic groups, such as racial and ethnic minorities, experience multiple barriers to accessing healthcare, including not having health insurance, not having a usual source of care, lack of transportation, lack of childcare. A growing body of evidence shows that health disparities persist even when insurance, income, and other access-related factors are controlled.

Health Portal: A Web site often sponsored by a large institution, which provides extensive information and contains links to a wide range of health and medical information on the internet.

Identity: Hecht (1993) identifies four frames through which identity is communicated. *Personal identity* involves self-concept, and develops through socially ascribed meanings and behaviors which are learned as one is socialized in a society (e.g., Black women stereotyped as mammy—the nurturer; jezebel—the seductress; sapphire—the wisecracking emasculating women; the welfare queen—the lazy, economically unstable mother of many bad kids). *Enacted identity* focuses on how messages express identity (e.g., I'm a black woman). *Relational identities* are those formed through one's relationships (e.g., I'm a mother). *Communal identities* are those shared by groups of people in some particular community (e.g., I belong to the Penn State community).

Menu-Driven Identity: This term signifies the ways in which content providers represent identities through the design of selection-oriented interfaces that are used to personalize content. Conversely, the term signifies the ways in which users perform their identity as they navigate within the choices that are both enabled and constrained by the interface.

ENDNOTES

1. http://www.healthypeople.gov/
2. http://www.mlanet.org/resources/medspeak/topten.html
3. This Web page in this screenshot served as the healthfinder start page when we conducted our analysis. This healthfinder Web site has been vastly improved, and the Web page used in our analysis is still accessible by clicking "Just for You" on the current start page.

A Historical Perspective of Australian Women in Computing

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INTRODUCTION

Women's participation in the Australian workforce has been increasing since the mid-1950s. In 1954, women made up 23% of the total labour force (Office for Women [OFW], 2004), but by 2004, they accounted for 44.5% (Australian Bureau of Statistics [ABS], 2004).

Over the same period, there was growth in new employment opportunities in the emerging computer industry. However, this industry did not manage to attract equal numbers of women and men, and currently women account for about one fifth of the Australian ICT workforce (Maslog-Levis, 2005). Women are paid less than men in similar positions in this sector and are less likely to hold senior management positions (Byrne & Staehr, 2003).

Gender imbalance in employment is not unique to computing. Australia's workforce is more gender segregated than that of most other industrialised countries (Gray, 2003). Over half of all female employees are employed in the clerical, sales, and service groups of occupations, and these are areas where there are substantially less men (ABS, 2000). Men dominate the trades, production, and transport occupations.

When does gender imbalance become a concern? Common sense would suggest that it has become a problem when gender imbalance has a detrimental effect on some sections of society.

The computing profession is an area where gender imbalance is of concern. New technologies bring about changes that have the potential to affect all society, and we "would be most likely to achieve maximum benefit if each significant section of society was represented in the planning decisions" (Ryan, 1994, p. 548). Without diversity in the ICT workforce, "we limit the set of life experiences that are applied, and as a result, we pay an opportunity cost, a cost in products not built, in designs not considered, in constraints not understood, in processes not invented" (Wulf, 1998).

Unless more women are employed in the areas of ICT design and development, these products and services are unlikely to meet the needs and desires of approximately half the population. Women need to be actively involved in all levels of these new technologies that have such immense potential for social change.

BACKGROUND

The ideas, curiosity, and advanced thinking that led to the creation of the computer evolved over time, with many people from around the world making a contribution.

Australia moved into the modern computing era with the development of the CSIR Mk1 in the late 1940s (Pearcey, 1994). This machine, later renamed CSIRAC, was the first computer in Australia, and it was arguably the fourth or fifth electronic stored-program computer ever developed in the world (Jones & Broomham, 1994). It provided computing service until well into the 1960s. By then, there were 34 computers in the country, and this number increased to 348 by 1965 and then to just over 3,000 machines by 1975 (Thornton & Stanley, 1978). By the year 2000, over 4 million computers were in homes around Australia, with over half (56%) of households having a home computer. In 2003, 66% of Australian households had access to a computer at home, with 53% of these households having access to the Internet (ABS, 2005).

In less than 50 years the industry had developed so rapidly that more than 264,400 people were employed in selected information-technology-related occupations in Australia (IIETF, 1993). Within this time frame, however, computers and computer work had also become stereotyped as more appropriate for males (Game & Pringle, 1984), and now only 23.6% of the current IT workforce are women. Women have tended to be highly represented in the less skilled, less sophisticated areas of data entry and computer operation, while men have made up the majority of the higher level, higher status, higher paid computer workforce (Davis, 1986).

EDUCATING THE COMPUTER PROFESSIONAL

Following the emergence of the new discipline of computing, the universities of Melbourne, Sydney, and New South Wales (NSW) first introduced courses on programming and the application of computers in 1956. By 1985, every Australian university had a computer department covering a wide range of curriculum areas. Two main approaches to the teaching of university computing emerged: computer-science and information-systems courses. In high schools, computing education was initiated in the mid-1960s "by a handful of enthusiastic maths and science teachers, mostly male" (Sale, 1994, p. 155).

The 1980s and early 1990s provided a period of enormous change in the Australian education system. High-school retention rates more than doubled during the 1980s, increasing from 34.5% in 1980 to 76.6% in 1993 (ABS, 1992). In 1987, for the first time, school retention rates for girls exceeded those of boys. Changing community expectations, a depressed teenage labour market, and government policies encouraging students to complete their secondary education were all contributing factors (Williams, Long, Carpenter, & Hayden, 1993). The result was an increased number of young people, particularly women, eligible to enter higher education. The first 130 years of Australian higher education saw women students outnumbered by men. Whereas female students made up only 45% of the student population in 1981, by 2001, women made up 57% of the 206,834 students commencing an undergraduate qualification (Office of the Status of Women [OSW], 2002).

It was in the mid-1980s that the lack of female students in computing in secondary and tertiary education as well as in the profession began to emerge as an issue and was finally recognised by academics, the industry, and politicians (see, for example, Kay, Lublin, Poiner, & Prosser, 1989; Symons, 1984). In 1990, the federal government attempted to improve the situation by setting targets to increase the proportion of women in university information-technology courses to 40% (see DEET, 1990).

During the following decade, many initiatives were created to encourage women to undertake undergraduate courses in information technology. Initiatives ranged from mentor programs to the production of videos, special classes for female students, curriculum changes to create a more inclusive curriculum, computer camps, and so on (see, for example, Clayton & Lynch, 2002; Craig, Fisher, Scollary, & Singh, 1998; Greenhill, Von Hellens, Nielsen, & Pringle, 1997).

Undergraduate female enrollments in computer science and information systems peaked at 27.2% during the early 1990s (Lang, 2003). In 2004, approximately 20% of commencing tertiary information-technology students were female (DEST, http://www.dest.gov.au/NR/rdonlyres/79212D3A-218C-D6D-9F28-7C59A9FE5F75/2464/01_Commencing_Students.xls#lTbl03>!Al). Australian women in the ICT profession are not only a small minority, but appear to be a decreasing one with a consequential reduction in diversity and creativity within the profession.

WHAT KEEPS WOMEN AWAY FROM IT?

A variety of factors impact Australian girls' decisions to not study computing.

RELATIVE COMPLEXITY

In my parents' lounge room after Christmas dinner, I am talking to my brother the computer programmer.
He is explaining to me the principles of cyberspace.
"It is only relatively complex," he says finally, peeling the icing off his fruitcake,"It is mainly a system of binaries, permutations of zero and one.

So, the data may be stored as, say, zero, zero, one, one, one, zero, zero, one."
My mother sighs.
She is next to us, half-listening.
She is knitting a fair-isle sweater.
"I'll never understand how you get your brain around it, " she says.
"It's beyond me," she says, and turns half her attention back to her fair-isle pattern: Purl, purl plain, plain, plain, plain, purl, purl. (Cate Kennedy, as cited in Senjen & Guthrey, 1996, p. 13)

Many women underestimate their ability to master complex procedures. Generations of Australian women have been able to knit complicated patterns, yet the skills involved in mastering the intricacies of this work are often unrecognised and undervalued. The language involved is distinctive to the craft work and understood in context, yet, the language of computers seems beyond comprehension to many women and can be alienating for those unfamiliar with the terminology.

With the rapidly changing nature of the industry there is a lack of information and understanding of what a career in the IT industry involves. The public image of the profession is not seen as one that involves creativity, problem solving, or working with people to help others, nor is it seen as requiring lateral thinking and good communication skills.

The impression is often that computing is word processing and spreadsheets, or made up of the Internet with students frequently unaware of the "vast body of underlying principles that make up the discipline" (Edwards & Kay, 2001, p. 334). Perceptions of IT being an industry dominated by math and science, and being technical, isolating, and lacking in teamwork and social interaction prevail (Multimedia Victoria, 2001). The enduring image of the computing industry is of young males, very technical and "nerdy," who spend most of their time working by themselves in front of a computer terminal. This is seen as unappealing and boring by many women.

In the 1980s and 1990s, high-school computing classroom experiences have often been associated with mathematics and competition to get access to scarce resources, and computing was perceived as a male domain. This influenced the decision of students, particularly females, not to pursue information technology (Cameron, Edwards, Grant, & Kearns, 2000). In the 21st century, computer classrooms are well equipped with many more resources and are much more user-friendly places. Yet, many students still frequently describe them as being too boring (Multimedia Victoria, 2001) and are not inspired to continue to a computing career. Many of the best IT students may be more knowledgeable than the teachers, are obsessive about technology, and "live" IT. This is not seen in other areas of the curriculum and can be a discouragement to other students to continue with computing (Multimedia Victoria).

The dot-com and telecommunications crash in 2000, and increasing offshoring and outsourcing have all contributed to the impression that IT does not provide a stable career (Morton, 2005). For women who do venture into the profession, there are few role models in the industry and a lack of suitable mentors. Many also find the nature of the work makes it difficult to balance work and family responsibilities (Newmarch, Taylor-Steele, & Cumpston, 2000). The industry is also seen as a "boys' club" with few women succeeding into management levels.

Generally, people are not consciously trying to discourage women away from computing. However, as Spertus (1991, p. 75) points out,

... people's behaviour is often subconsciously influenced by stereotypes that they may not even realise they have. While perhaps it is comforting to know that no conspiracy exists against female computer scientists, it also means that the problem is harder to fight.

REDRESSING THE IMBALANCE

One approach that has been identified in the literature to redress the imbalance of women in the ICT profession is that of "women-in computing." This is where change is expected to come about via policies and strategies to create equal access to education and employment (Pringle, Nielsen, Von Hellens, Greenhill, & Parfitt, 2000). This has been described as the "add women and stir" approach, which may have limited potential as it locates the problem in women rather than in the gendered culture of the ICT workplace (Adam, Howcroft, & Richardson, 2002). A second approach, then, is "women in-computing." Here, change is expected to come about from reshaping the industry to accommodate women by altering the masculine practices of ICT work so that women can enter into such work without the loss of identity or integrity. This approach has a broader focus on the nature of technological work—the source of the inequality—and how it can be made more inclusive of women.

Adopting both approaches, however, can be considered as mutually reinforcing. If more female students can be encouraged to enroll in computing courses, or participate in the industry, then there will be a greater presence that will help to transform parts of the culture. Changes in the culture itself will then encourage more females to participate. Webb and Young (2005) have suggested that it is now timely to consider adopting a different research approach, feminist epistemology, which would offer greater insights into the factors involved in the imbalance of women in the ICT profession.

The lack of women participants in the ICT profession is not unique to Australia. There are many other countries, for example, the USA, United Kingdom, Germany, the Netherlands, and South Africa, where the problem also exists (Galpin, 2002). Yet the ICT profession is gender neutral in other areas of the world such as Malaysia, Singapore, and Hong Kong. A conclusion that can be drawn from this is that it is not inherent ability that is stopping equity within ICTs, but it is much more likely to be cultural and societal influences. Teague (1997) warns that since the environmental and behavioural factors related to the imbalance of females in the ICT field are now essentially part of Western society, it may take generations to change the imbalance.

Gender shifts are possible, however. In Australia, for example, in the early 1970s less than 15% of veterinary graduates were female. Yet almost all in the veterinary profession would agree that gender is not an important attribute to be a successful vet. Currently, more than 50% of all enrollments in veterinary science are female. During this period, the image of veterinary science has undergone a remarkable shift. A very popular TV show, *A Country Practice*, introduced a female vet who was charming, clever, and attractive. Another show, *All Creatures Great and Small*, portrayed their two male vets in a "highly positive, socially friendly and supportive, and people oriented way" (Byrne, 1994). Similarly, an increased interest in forensic-science education has been attributed to the popularity of television shows such as *CSI* (Selinger-Morris, 2005). Popular movies such as *Hackers*, *Sneakers*, *War Games*, *Antitrust*, *The Net*, and *Swordfish*, however, do not present an image of computing that is appealing to many women.

FUTURE TRENDS

The statistics indicate that in Australia, the numbers of women in computing education and the profession are not increasing. However, in 2005 it is possible to be optimistic. The issue appears to have once again been noticed by the education sector, the corporate sector, professional societies, and the government. An indication of the growing awareness can be seen by the following initiatives.

- The federal government announced plans for the Women in ICT Summit to be held in September of 2005.
- The Victorian Women in ICT Network was created as a response by the Victorian government and industry to the impact of the low participation of women on the skills base of the ICT industry.
- The Australian Computer Society (ACS) established a women's board, ACS-W.
- Many of the existing ICT networks for women that have been formed throughout Australia will work more closely together in the future. In May of 2005, the Australian Women in IT and Science Entity (AWISE) was created as a national communications umbrella that formed a collaborative voice connecting many of these ICT networks (for example, GIDGITS, Women are I.T., Women in Technology, FITT, WIIT).

These initiatives need to be the catalyst for real change.

CONCLUSION

Many programs have been introduced to try to address the complex range of factors that affect young women's choice to commence and successfully complete a degree in computing, and to equip them with the necessary skills and contacts to obtain jobs and career recognition in the industry. Due to the ever-changing nature of technology itself, it would be simplistic to expect that the problems have remained the same over time and that the strategies that have worked in the past will be the same ones producing results in the future.

Yet, it is necessary that we continue to work to redress the imbalance in the computer workforce. Women can bring a different perspective and alternative skills to the computing profession that will help create better systems for all. The entire computing industry within Australia needs to recognise the importance of the issue, and the political will needs to be found to make a lasting difference.

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KEY TERMS

CSIR Mark 1: Australia's first automatic electronic computer. It was developed by the Council of Scientific and Industrial Research in Sydney. Today, it can be found in the Melbourne Museum.

Gender Segregation: When the percentage of the share of employment for a gender in an individual area is well above or below the corresponding share of total employment for that gender.

ICT Industry: The information and communication technology industry.

Nerdy: A term used to describe a person who is very interested in and focused on computers, but who is felt to be socially inept.

Tertiary Education: Coming after primary and secondary education, tertiary education refers to university- and college-level education.

History of Feminist Approaches to Technology Studies

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INTRODUCTION

While women have historically engaged with technological practices and processes as designers, producers, users and consumers, technology itself has been socially constructed as a masculine domain and inherent to male gender identity. As a result, women have not been recognized as technological participants, nor have they had their contributions validated. To understand this exclusion, different feminist approaches have been historically utilized to help situate the framing of technology as a masculine domain that is organized by the social structures of patriarchy, capitalism, and social stratification. Feminist approaches have been used to deconstruct the defining of technology as masculine, to illuminate the historical ways in which women have been part of technological fields, and to give evidence of the pleasure and empowerment women can feel with technology.

BACKGROUND

There are two principle approaches that are typically expressed when examining the nature and role of technology in society. The first, technological instrumentalism, suggests that technology is merely a neutral tool to be used as the human agent deems necessary. For good or for bad, it is people who dictate the utilization of technology (Mowshowitz, 1985). By contrast, technological determinism suggests that technology is the underlying cause of change in society. People in society are viewed as having no control or choice about how or whether to utilize technology (MacKenzie & Wajcman, 1999). In both approaches, technology is depicted as evolutionary and self directed and on a path of change that is forever expanding with knowledge.

What is absent in both is the recognition that social and historical contexts can determine the formation and cultural meaning of technology. Technology is not a ready-made tool; it is a tool made by people. Technology is infused with the dominant beliefs, attitudes, and ideologies of the society in which it has been conceptualized and developed. Living in a world where patriarchy, capitalism, and inequality structure social relationships, technology comes from, and is shaped by, these prevalent relations (Cockburn & Furst-Dilic, 1994). To understand the meaning of technology is to go beyond the physical hardware to include the complex human activities that are also technology.

The contemporary association of science to masculinity and nature to femininity arguably arose during the Scientific Revolution where the Enlightenment philosophers inherited sexist attitudes from Aristotelian philosophy that defined women as passive and intellectually inferior to men (Arnold & Faulkner, 1985). Francis Bacon called for a science and scientific method that would permit the discovery and conquest of the secrets of nature. Nature, located and identified as female, would be penetrated, conquered, and transformed (Easlea, 1983). The rise of gender roles and identities as binary opposites came to be organized through the Enlightenment period. Masculinity has become linked with rationality, hierarchy, dominance, strength, independence, power, control, aggression, ambition, and logic. Femininity has thus become connected to the oppositional attributes: irrationality, community, submissiveness, weakness, dependence, family, intuition, and softness. More typically, these characteristics are reduced to essentialist divisions that locate male/female as mind/body and technology/nature. Thus, through the Scientific Revolution, masculine identity became connected to science/technology and intelligence, and conversely, femininity was defined in terms of its non-connection. As a result, the artificial linkage between masculinity and technology became socially enshrined and now is culturally accepted without question (Murray, 1993).

Wajcman (1991) and Cockburn (1985) take as their starting point a different historical point of analysis: the move to capitalism and the creation of a sexual division of labor. Both authors make the similar claim that the sexual division of labor under patriarchy and capitalism has given rise to particular gender roles and values that locate women in the private home sphere with children, and men in the public work sphere with technology.

Cockburn (1985) focuses specifically on the transformation towards gender-specific work from feudalism to capitalism. With this transformation, men were given more social power and status compared to women under capitalism because they had knowledge and technical skills that were necessary for work place productivity. The rise of guilds as a center for trade skills limited women's access to skill development or the manufacturing of tools. Women's work became restricted to the domestic realm, with women responsible for food, childcare, and domestic duties. However, Cockburn's analysis of technology and masculinity is limited as it only attends to the technologies utilized in the capitalist public and paid workplace. She seems to be falling into the trap of defining technology as being only the technologies of production—those valued under capitalist and patriarchal structural relations.

While Cockburn (1985) focuses exclusively upon the technologies of production, Wajcman (1991) broadens her areas of exploration to include reproductive, domestic, and architectural technologies. In her research, she argues that the very definition of technology has been shaped by patriarchal and capitalist relations that only value productive workplace technologies. By focusing on a broader range of technologies, Wajcman exposes how technology exists as masculine identity which is caught up in the domination of women. This does not imply that all women lack technological skills or that all men have technical expertise, but that women and men are both structurally located through norms of hegemonic gender roles. As a result, women's use of technologies for work has been overlooked, and technologies used by women outside of the workplace, such as reproductive, domestic and leisure technologies, have been ignored as they are not viewed as being technologies. Wajcman outlines multiple and often intersecting social processes that lead to women's alienation from new information and communication technologies (ICTs). This includes access to technological equipment, gender biases in education and the family, and the design of computer programs and games.

A parallel historical analysis of the social construction of technology as a masculine activity and identity suggests this gendered affiliation arose as a result of the masculinization of the military and engineering. Hacker (1989) argues that historically, the military, as an institution, arose from fraternal interest groups, where men lived with their families and passed along their name through their children. This social structure inherently relocated the women as outsiders to the group dynamics. In exchange for food, among other forms of labor, men promised to protect the community of women, children, and the elderly. Male military labor was valued more highly than female community-oriented labor, as only the men were paid. Engineering arose as a discipline designed to train men to be the technical staff and administrators of the military. The first military academies were engineering schools, focused upon teaching students technical skills and occupations. Since engineering was a technical branch of the military, technology became associated with the military, masculine identity, dominance, and power. In turn, as engineers graduated, they moved these internalized values into their workplaces—back into the military, or out into the capitalist labor market. Consequently, women in contemporary society still experience significant difficulties in being accepted members of technology-based fields, such as engineering and the military.

INTERSECTIONS OF WOMEN AND TECHNOLOGY

While the dominant cultural ideology connects technology with masculinity, women have always engaged with technologies and technological practices in their every day lives. Historians and scholars have documented many of the ways in which women have been the ignored and marginalized creators, developers, and users of ICTs. Thomas Jepsen's (2000) studies on the history of women and telegraphy highlight the active role women played as telegraph operators in the mid 1800s. Women entered the field at its inception, and participated in this early telecommunications industry as managers and as operators. Similarly, women have been prominent in other information and communications fields such as the U.S. telephone industry, where young, single women were hired in the late 1870s. Women inventors have held patents on a variety of early domestic and communication technologies, including boilers and cooking devices, typewriters for the blind, rotary washers, and submarine telescopes (Herring, 1999). The history of women in the computer industry is becoming well documented, with the contributions of Ada Lovelace, Grace Hopper, Alice Burks and other women being recognized as culturally significant. Women have always been engaged with technology, yet their historical contributions have been ignored as a result of the gender encoding of technology as inherently masculine.

Feminist Reticence to Technologies

While feminist scholars have been critical of the cultural framing of technology as a masculine domain, this is not to suggest women as a whole are against technology. Rather, these scholars have been fundamental in illuminating the myriad of ways by which this social construction of technology as masculine has negatively impacted upon women. For some women, the masculinization of technology has resulted in female technophobia, and the early lack of interest by women in adopting computer technologies. Feminist responses to advances in technological fields of the 1960s and 1970s was largely negative due to the cultural construction of technology as inherently masculine and patriarchal (Stabile, 1994). A female resistance and reticence towards new technologies such as home and work computer systems, and new technological spaces such as the Internet, has been the result (Turkle, 1988).

In examining the impact of new information technologies on women's work places in Canada, Heather Menzies (1981) clearly documents how female employees were more negatively impacted with the introduction of new workplace technologies. The introduction of computers and new ICTs resulted in an increase in part-time work, isolation, unemployment, and telework from home. These practices are still evident today, where women's experiences in new ICT fields are often times negative as a result of lower salaries, barriers to management promotion, competing demands on time due to family commitments, and an increased pressure to telecommute (Kome, 2003).

Early feminist Internet writers such as Dale Spender (1996) initially identified cyberspace as problematic for women–a place where they would be excluded, flamed into silence, cyberstalked, and inundated with pornography. Men shaped and determined the early culture of the Internet to reflect their own interests, creating virtual spaces that marginalized or ignored women's equal participation as producers. Spender argues that women have been stereotyped as the consumers of online information, not creators or producers. Men are viewed as the decision makers in cyberspace. Many of these early feminist concerns over the shaping of the Internet as a space hostile to women continue to exist today, especially as the WWW becomes more capitalist and corporate, and pornography continues to grow as a dominant Internet industry (Sutton, 2003).

As the Internet was accepted as part of the new social landscape in the mid 1990s, women began to challenge the societal belief that these new information and communication spaces were only of interest to men. Women existed and continue to exist in cyberspace, and actively participate in using the Internet for work, activism, and networking. It is the capitalist and patriarchal construction of cyberspace as a male space that has made women's participation invisible and marginalized, and their online identities limited to consumptive practices. The barriers that may discourage or turn women off the Internet are culturally created and are thus open to resistance, and reformation. Technophilia becomes a different female response to the empowering potentials offered to women by ICTs.

Technology for Female Empowerment and Pleasure

The potential for feminine pleasure in the blurring of gender and technology boundaries is perhaps articulated best by Donna Haraway (1991). Through feminist cyborg theory, she offers up a new vision of technology and gender in which women and men can break free of the binary divisions allocated to gender, and take pleasure in rejecting wholeness and unity linked to identity. In feminist cyborg theory, the cyborg represents the potential for the empowerment of women, the rejection of female technophobia, and the dismissal of technology as an exclusive masculine territory. The female cyborg symbolizes a rejection of the traditional binary allocation of technology to masculine identity, positively reworked from a feminist position. The female cyborg, as an icon and identity, represents the blurring of boundaries that have been used to distinguish between male/female, and technology/nature. This permits the reinterpretation of differences in society and the creation of new identities from multiplicities where women are able to be fused with technology. As a sign of female empowerment, the female cyborg represents what women need, namely an ease with technology that will allow them to participate, take pleasure, and have control.

Haraway's (1991) theoretical construction of women empowered and taking pleasure in technology is taken up by late 1990s cyberfeminists. Cyberfeminism, as a new concept and feminist theory, moves beyond feminist concerns over the social construction of technology as masculine. Instead, recognizing that ICTs and computers are embedded features of the contemporary global landscape that cannot be rejected, cyberfeminism highlights a fundamental paradigm shift for how gender and technology can be conceptualized. In this model, women can be empowered by, and take pleasure in, ownership and management of new ICTs (Wilding, 2001).

This is not to suggest that women need to accept the dominant paradigm in order to be accepted into technological fields. What is empowering within cyberfeminism is the understanding that the stereotyping of technology as being a masculine domain and practice must necessarily fall apart across time. Women who have grown up with new information technologies have easily accepted technology by its everyday presence in contemporary society (RosieX, 1995). Women should make use of new technologies, reject the dominant societal belief that technology is only that which is productive, contribute to the global formation and shaping of new technologies and technological spaces, and take pleasure in the overall process (Plant, 1997).

Encouraging women to enter cyberspace is not the main objective of cyberfeminism. E-commerce has been strong in encouraging women to go online in order to access a new market population of product consumers. Commercial portals are now targeting women as a distinct consumer group, and many women-oriented portals like Women.com have arisen. Yet these types of women's portals are not feminist or empowering to women, and most offer the type of traditional gender-based content found in women-oriented magazines–advice on beauty, fashion, romance, and heterosexual intimacy. Cyberfeminism is about women becoming active agents in contributing to the formation of knowledge through technological spaces such as the Internet.

While feminist cyborg theory and cyberfeminism offer a contemporary feminist challenge to the traditional construction of technology as inherently masculine, they are not without their limits for assisting women in overcoming female technophobia or reticence. Both have been challenged for being abstract and not connected to the socio-cultural inequalities that result in differing levels of access and interest by women to technologies and cyberspace. Not all women have access to the Internet and new ICTs, given differences in education, economic power, existing global infrastructures, and the dominance of English within cyberspace (United Nations Division for the Advancement of Women, 2002). In addition, many women who now utilize information technologies and personal computers for labor practices exist in a world where these technologies intensify their daily workloads.

FUTURE TRENDS

While women globally continue to engage with technologies in all aspects of their lives, the on-going masculinization of technology is still evident and has significant impact upon women's experiences with technology. Feminists still continue gender-based research on a wide range of technological practices, domains and careers, especially as new ICTs become more heavily embedded in contemporary society. Some recent issues that are being explored include women bloggers and life writing, access issues for women with disabilities, globalization and women's technological labour, the Internet and the trafficking of women, women's underemployment in video game industries, the sexual exploitation of women online, the rise of cybercottage industries, the potentials for feminist cyberactivism, and using new media and technologies for teaching women's studies.

CONCLUSION

What is becoming increasingly clear is that technology is simultaneously organized by the socially stratified systems of patriarchy and capitalism. This is not a process occurring in isolation. Technology exists in particular formations because of its intersection with power and culture. As a result, technology does not function in the existing world as a value-free artifact, but rather it exists as an object that is value-laden. The implications of this gendered encoding of technology are culturally significant, whereby technology-based disciplines such as engineering, the sciences, mathematics, computer sciences, and information technology management have been historically dominated by an ideological belief system that assumes men are the developers, producers, and primary users of technological products and processes. As a result, women's historical contributions have been marginalized, and women have not been equal participants in the development, production or use of new information technologies, and have had to fight for inclusion in technology-based fields.

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KEY TERMS

Cyberfeminism: A feminist approach that arose in the 1990s to challenge and recontextualize the functions of new information and communication technologies and the Internet for women. It favors female pleasure and empowerment through feminist technological practices, and explores the intersections between gender identity, the body, culture, language, and technology.

Cyborg Theory: A theoretical framework upon which to examine the contemporary cultural intersections of human bodies, technologies, and identities. The female cyborg symbolically represents the disruption of dominant binary divisions that links women with nature and men with technology.

Gender: Socio-cultural values that are differently assigned to the physical bodies of men and women, whereby masculine attributes are typically linked to the male body and feminine attributes are typically with the female body.

Technological Determinism: An approach to understanding the role of technology in society that claims technology exists outside of society, has its own built-in functions and goals, and is the primary cause of social change.

Technological Instrumentalism: An approach to understanding the role of technology in society which conceptualizes technology as a device or tool where the user makes choices surrounding and determining its usage.

Technology: Technology is typically understood as physical objects that exist usually in the form of machines or tools. However, technology also includes human beliefs, values, activity, creativity, energy, and knowledge.

Technophilia: An excitement and eagerness for new technologies and technological practices.

Technophobia: A fear of technological innovation, computer systems, or technological cultures.

How Gender Dynamics Affect Teleworkers' Performance in Malaysia

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eHomemakers, Malaysia

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eHomemakers, Malaysia

INTRODUCTION

eHomemakers (http://www.ehomemakers.net), also known as Mothers for Mothers when it was first formed in 1998 in Malaysia, is a network of mothers and working-at-home persons from multiethnic communities. They are of various ages and are involved in networking activities to develop and promote the concept of working at home. The network believes that through ICT, homemakers, especially mothers, can earn an income without having to leave their homes or sacrifice their family responsibilities in the Malaysian social context. ICTs allow women to balance home and work life, thus enabling them to have the best of both worlds (Yip, 2000). In 2003, eHomemakers was a testing partner of the Association of Progressive Communications' (APC, n.d.) worldwide Gender Evaluation Methodology, and an evaluation plan titled "How Gender Dynamics Affect Teleworkers' Performance in Malaysia" was written.

eHomemakers aims to use the evaluation results to promote the creation of telecommuting opportunities and the establishment of virtual offices to the Malaysian government and the corporate sector. The findings are especially valuable to organisations that have tried telecommuting unsuccessfully. They also serve as a performance guide for teleworkers and would-be teleworkers who juggle child care, household chores, and paid work at the same time. The study was also used as a guide for eHomemakers to launch a special national campaign to advocate the promotion of teleworking for women.

BACKGROUND

Objectives of the Study

The main objective was to explore how women's family lives and home situations affect teleworking and work performance. The evaluation team conducted group discussions and interviews to identify the following:

1. Barriers and challenges faced by women who work from home
2. Ways in which working from home has impacted the women's lives and their families
3. Optimum home-office situations of a group of virtual office members
4. Characteristics and skills needed by a woman to be able to benefit fully from working from home

Research Questions Analysed

The following research questions were analysed.

1. How ICTs and gender issues affect telecommuting
2. How (if at all) ICT can affect the efficiency and productivity of a teleworker
3. How a teleworker can use ICT as a tool to balance home life with work life, and still be efficient and productive in her work performance
4. What conditions enable women to be efficient teleworkers

Methodology

The study took 4 months to complete and involved 70 respondents. The study team used a triangular methodology: home visits, focus-group discussions (FGDs), and a questionnaire survey. Respondents of the study included members of eHomemakers' virtual team (VT), staff members who worked from home, and eHomemakers members. The selection of respondents was made based on one key criterion: They were mothers who have been multitasking and working at home for less than 3 years. The justification for the criterion is that mothers who have just become teleworkers need time to adjust to their new lifestyle and so they face more barriers and challenges than mothers who have worked at home for more than 3 years. Except for the VT members who had fixed fees per month, all respondents worked on a freelance basis with their home-based consultancies against the backdrop of an unsupportive social and business environment.

Only two fathers who telework were included in the study as a control as it is not socially acceptable still, for men and women, to telework.

RESULTS OF THE STUDY

Reasons for Getting into Telework

All the VT members had experienced working from a physical office. The majority of the women gave up their jobs to become mothers, full-time homemakers, or home-based workers. A few got into home-based work as a result of retrenchment. Most were married while one was a single mother.

A similar pattern is reported by Amyot (1997) for a Canadian survey. The respondents, predominantly women, chose teleworking as an alternative to working full time in a regular office. Edwards and Field-Hendrey (2002) found that teleworking was a viable alternative because of the greater flexibility it afforded to people who have responsibilities at home like caring for children, or aged or disabled persons.

Benefits of Teleworking

All the respondents agreed that the biggest benefit was flexible time management. The female respondents made it clear that their first priority is their families and that most of them had left their former careers to raise their children.

Some of the women mentioned an increased sense of confidence that comes from having their own income and not relying on their husbands for their expenses. They also emphasised that they enjoyed being involved in something outside the realm of their husbands and children. They felt that it is important for women to have interests beyond the home and that teleworking improves their overall relationship with their husbands and children. Their ICT skills had also greatly improved because, unlike in the office, they had to learn how to troubleshoot minor computer problems on their own.

One respondent related how she was able to negotiate with her husband to start taking on some of the household tasks. Prior to her home-based business career, she was expected to do everything at home even though she was working full time outside while her husband claimed he was too tired from work to help out at home. Now, she used the same reason (being too tired because she is working) to get her husband to do some of the tasks himself.

Other benefits cited include not having to deal with traffic jams, saving time, not having to deal with office politics, and not having to worry about office wardrobe and how you look.

Other studies have also cited the advantages of teleworking. They range from flexibility in working hours to better quality of life and increased job satisfaction (Abu Hassan Asaari & Karia, 2001), as well as a lifestyle that allows workers to concentrate on the household and thus combine paid and unpaid work in the same workplace (Osnowitz, 2005).

Factors that Affect Home-Based Work

Perception of Home-Based Work

One of the barriers encountered was the negative perception about home-based work by family members and peers. Home-based work is often not considered a real job, and consequently, family members often interrupted the respondents' work and assumed that they were available for a chat, to run errands, or to do household work because they are home based.

For the male respondents in this study, there was the added pressure of not appearing as breadwinners of the household. One respondent mentioned the difficulty of being a "modern husband" and that the Malaysian culture expects husbands to work from physical offices as the sole (or at least the primary) breadwinners.

These views, however, were expressed primarily during the first few months of starting home-based work. Over time, by explaining what they did and how they worked from home, the respondents let their families and communities know that teleworking was just as serious and as valid as office-based work. As a result, the two male respondents in particular experienced less interruptions from family members.

Support from Family Members

The majority of respondents reported that support from family members was critical in the success of working from home. Children and spouses must understand that the teleworker should not be distracted when working. Respondents with very young children made arrangements with other family members (their mothers, aunts, sisters) to take care of the children during their work hours. Most of the respondents had household help, but they preferred their kids to be looked after by family members. They also said that when starting up the home office, support from family members was very critical in the first year. For example, one respondent reported that her husband would not allow her a dedicated workspace.

On the whole, most respondents claimed that they had various forms of support from their spouses. Some spouses offered technical and work-related support. Other husbands took care of children when their wives were working, especially during weekends. A female respondent related how she had become less critical of her husband's contribution to household tasks. She had since learned to let go of her ways of doing things at home, allowing her husband to do some of the household work even if it did not meet her standards.

Lack of Technical Support

Respondents who used computers in their home-based work experienced difficulties from the lack of technical support at home. When they had technical problems, they either paid for repairs or called on VT members for help. Some called on their husbands or their children to provide the support they needed. According to one respondent, repair services are expensive, and home-based work is more expensive than office-based work where free technical support is available. They did not confirm whether they took the trouble to learn basic computer-maintenance work.

Labour Policies in Malaysia

Respondents raised the issue that Malaysian labour laws should recognize teleworking as legitimate work and should include the same benefits and support given to government office-based workers. Presently, teleworkers do not get any low-cost insurance or tax benefits.

Cost of ICTs in Malaysia

The focus groups were interested in learning more ICT skills to improve their teleworking opportunities. However, aside from a lack of affordable training for women, the high cost of ICTs was of concern to homemakers who were just starting out with no or little support from their families.

Management Issues

Most of the respondents interviewed talked about the need for the better management of VTs. They felt that there is little opportunity for management to monitor or verify the work of the team and that management's no-nonsense mind-set is crucial in ensuring that teleworkers are accountable professionally. This type of work arrangement calls for management to be very clear and focused on what it expects from the staff. The respondents also mentioned the importance of transparency from management in terms of payment schemes, decision making, and performance evaluation criteria.

RECOMMENDATIONS FOR CREATING AN ENABLING ENVIRONMENT FOR TELEWORK

Based on the findings, the following recommendations were made.

Increased ICT Access

As Malaysia positions itself to be a regional ICT hub, teleworking should be considered a work option for the increasingly educated women in the workforce who want freedom to define their choices. Also, outsourcing to teleworkers can be a reality if conducive policies are in place. Affordable ICT tools and universal access should be ensured (Mitter, Jin, Hoon, Wong, Abdullah, Rasiah, et al., 2001). ICT access is not so much of a problem in the capital, Kuala Lumpur, and the satellite areas; however, the costs are still too high. ICT access in other areas is much higher.

A person going into telework requires, at the minimum, a PC (personal computer), telephone, printer, and Internet access (Yip, 2000). As such, not everyone can afford to set up a home office. Although the respondents saw the purchasing of these tools as necessary investments, most Malaysian women do not have such means. While the obvious solution is to lower the costs to individual homes, alternative solutions such as loan schemes and affordable community Internet-access centers could be explored.

Training and Skill Development

Affordable ICT training and working from home are necessary to develop teleworking survival skills and to ease the difficulty of entry. Peregrine Wood (2000) confirms that rapid changes in technology require women to continuously learn new skills to increase their capacity to adapt.

Professional Management

The management of home-based workers must be professional, but not totally simulating the management of normal office work. Paradigm shifts in management and work culture are necessary (Mitter et al., 2001). Alternative management plans for home-based workers should take into account the multiple roles of women (and men) working from home.

A VT needs an efficient communication system and well-tested office accountability procedures that allow for transparency in decision making and performance evaluation criteria.

Effective monitoring practices ensure the accountability of teleworkers on fixed or retainer fees. One of the benefits of teleworking is time flexibility, which allows the workers to attend to their family roles and responsibilities. Instead of focusing on time spent doing a specific task, home-based management schemes must be specifically output driven with clear tasks, deliverables, and deadlines. Such management schemes must also make full use of available technologies to ensure transparency and accountability.

Changes in National Labour Policies

The International Labour Organisation (ILO, 2005) recognizes the substantial contribution to national economies from women entrepreneurs in both the formal and informal economies. In view of this, current labour policies in Malaysia must take into consideration the multiple roles of teleworking mothers and offer all home-based workers the benefits they give office employees (Abu Hassan Asaari & Karia, 2001). Any new policies on home-based work must ensure the protection of workers' rights.

DISCUSSION AND CONCLUSION

Gender Roles

Given that the respondents have been working from home only for a few years, and teleworking in Malaysia is in its early stages, conclusive findings about how teleworking challenges traditional male and female roles in the home is still premature. The long-term effects of teleworking on women's lives and gender relations in the family cannot be drawn without the same study being conducted on a larger number of respondents. However, the present findings shed light, for the first time, on the relationship between teleworking and the gender roles and inequalities in Malaysian families.

At first glance, teleworking can be an ideal solution for women to fulfill their multiple roles (Mahmood, 2002). The rapid ICT development in

Malaysia offers more opportunities for women, especially mothers, to work from home, decreasing the stress of juggling both family responsibilities and income earning (Tan, 2000). However, the long-term socioeconomic effects and implications of teleworking on gender roles should be studied (Suzan, Sixsmith, Sullivan, Hootsmans, & Clason, 2001) to determine how it should be promoted with the least negative effects within the Malaysian family context.

Although the respondents claim to be empowered with increased confidence, how their empowerment affects their relationships with their husbands and family members should be explored further as Malaysian culture is still quite patriarchal. Does teleworking truly challenge and change existing gender roles and inequalities?

Given that Malaysian women continue to fulfill traditional gender roles despite education advancement, home-based work can clearly address practical gender needs without necessarily challenging socially (and internally) accepted roles of women and men in the home (Hulten, 2001). Home-based work can become an ideal compromise for women so they can continue to fulfill their roles as mothers and homemakers. The respondents in this study gave up their careers and accepted their roles in the family. They believed in the importance of the mother as the main caregiver in a traditional family situation.

But what of the males in the family? Does having a wife who works from home further excuse them from being more involved in household work and family roles?

The two fathers interviewed confirmed that they are taking on more household work and are more active in raising their children as a result of working from home. If so, teleworking does challenge existing gender roles in the family, and it might be better to promote it among fathers. To have them physically present in the home can result in them being more involved in household tasks and management, thereby changing the division of labour in the family. In the Asian context, however, where extended families are still prevalent and household help is affordable, teleworking fathers may not necessarily attend to household work. They can easily leave household work to other (female) members of the family or to (female) household help. In this case, having men working from home will not challenge gender roles.

Promotion of Teleworking

According to the Malaysian Department of Statistics, currently over 50% of Malaysia's female population are not in the labour force although their literacy and secondary-school graduation rate slightly surpassed that of the male population (Buku Tahunan Perangkaan [Year Book of Statistics], 2002). In 2000, women comprised only 46.7% of the total Malaysian workforce. The figure has hovered around there since the 1990s due to the lack of opportunity for women to take care of children and work at the same time. Malaysian culture still values a mother's care more than paternal involvement in child care (Kulasegaran, 1999).

Teleworking brings paid work into the home, and it needs to be further advocated to the Malaysian government. The first step to promote teleworking is to validate teleworking as real and professional work in the same way that household work must be recognized as real work (Suzan et al., 2001). Giving economic value to unpaid housework will reduce the general perception that telework is a working mother's only other option besides homemaking. Teleworking should be advocated as a means to liberate mothers from traditional means of work and propel them into the information age.

Major barriers for telework exist. Local employers are already reluctant to hire women of childbearing age. Hence, promoting teleworking to them requires further studies on effective monitoring processes and measurement of mother teleworkers' productivity. Cost-benefit studies with elements of workers' rights protection will also be needed to convince employers of the benefit of engaging mother teleworkers.

However, promoting teleworking as a viable solution for women should be done carefully not only to overcome misconception of telework, but also to overcome the perception that teleworking reverses women's advancement. Women activists have fought to get out of their homes into offices to achieve equality with men in the workplace, and to live outside of traditional homemaking. Promoting teleworking specifically for women challenges their feminist stand.

At the individual level, mother teleworkers need to be aware that self-monitoring and discipline are the keys for teleworking success. More awareness training and promotion of eHomemakers' teleworking-community network will be essential to spur the movement onward through essential information dissemination, especially on gender roles.

CONCLUDING REMARKS

The findings show that indicators and benchmarks in terms of changes in gender relations as a result of teleworking must be developed, and that the evaluation of teleworking from a gender perspective must be continuous.

If teleworking promotes gender equality in the family, both women and men must challenge traditional gender roles and stereotypes, and work on true equality between husbands and wives in all aspects of family life: in decision making, in household work, and in family responsibilities. If this equality is not embedded alongside the promotion of teleworking, all teleworking can do for women at best is to provide an opportunity for women to balance their gender-based roles and responsibilities better, and at worst, to be used to justify women's multiple burdens.

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KEY TERMS

Home-Based Work: Income-generating work that involves teleworking or running a home-based business.

Information and Communication Technology (ICT): Information and communication technology is the technology required for information processing. In particular, it is the use of electronic computers and computer software to convert, store, protect, process, transmit, and retrieve information from anywhere, anytime.

Teleworker: A teleworker is a physical person working from a distance whose work involves using information and communication technologies.

Teleworking: Teleworking means working from a distance through the use of telecommunication technologies. It also means employment at home while communicating with the workplace by phone, fax, or modem. The word telecommuting is synonymous with teleworking.

Virtual Team: Remotely situated individuals affiliated with a common organisation, purpose, or project who conduct their joint effort via electronic communication.

ICT and Gender Inequality in the Middle East

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INTRODUCTION

Information communication technologies (ICT) have become an effective force for accelerating political, economic, and social development, decreasing poverty, and fostering trade and knowledge; however the uneven distribution, usage, and implementation of ICT resulted in what is known as the "digital divide" between those who have access to and utilization of information resources and those who do not (Internet.com, 2004).

The Middle East, with the exception of Israel, is the least ICT connected area worldwide with only 1.4% of the global share (less than half of the world average of 5.2%). ICT adoption and access in the Arab world are far from adequate; only 6% of the Arab world population uses the Internet, while the penetration rate of personal computers is 2.4%, and less than 4 % of the Arab population has access to a ground telephone line (Ajeeb, 2006; NUA, 2005).

The trend of globalization forced Arab countries to realize the power of ICT as one of the most important factors in achieving sustainable growth. During the past decade, genuine efforts have been implemented by Arab governments to utilize ICT; as of May 2005, every country in the Arab world (as seen in Table 1)—except Iraq and Libya—has a clear strategy or at least a plan for promoting ICT (Dutta & Coury, 2003).

In her book, *Technology Strategies for Putting Arab Countries on the Cyber Map*, Reem Hunaidi (2002) stated that despite Arab world efforts to utilize ICT, Arabs are still far from bridging the digital divide. Hunaidi stated that the Arab world is still scoring low on the Digital Access Index (as seen in Table 2), adding that bridging the digital divide requires commitment from all development stakeholders, not only Arab governments.

The Hunaidi study concluded that development should start within the Arab society through liberating Arab human capabilities, especially those of women questioning how a society can compete in an increasingly globalized world if half of its people remain marginalized (Hunaidi, 2002).

The UNDP 2004 report on human development in the Arab world added to Hunaidi's question

Table 1. ICT in the agenda of the Arab world

Country	ICT Strategy Spelled Out	ICT Implementation Plan Articulated	Operational ICT-Dedicated Research Facilities	Plan of ICT Dedicated Research Facilities	Operational Technopole Initiative	Plan of Technopole Initiative	Existence of Technology Incubator	Planned Technology Incubator
Bahrain	✓	✓	✓			✓	✓	✓
Kuwait	✓		✓	✓		✓		✓
Oman				✓				✓
Qatar	✓							✓
Saudi A.	✓	✓	✓	✓	✓	✓		✓
UAE	✓	✓	✓	✓	✓	✓	✓	✓
Algeria		✓	✓	✓		✓		✓
Egypt	✓	✓	✓	✓	✓	✓	✓	✓
Jordan	✓	✓	✓	✓	✓	✓	✓	✓
Lebanon	✓	✓	✓	✓		✓		✓
Morocco	✓	✓	✓	✓	✓	✓	✓	✓
Syria				✓				
Tunisia	✓	✓	✓	✓		✓		✓

Source: Dutta & Coury, 2003

Table 2. Digital Access Index (DAI)

UAE	0.65
Bahrain	0.58
Qatar	0.55
Lebanon	0.48
Jordan	0.45
KSA	0.44
Oman	0.43
Libya	0.42
Tunisia	0.41
Egypt	0.40
Palestine	0.38
Algeria	0.37
Morocco	0.33
Syria	0.28
Yemen	0.18
Sudan	0.15

Source: ITU, 2004

stating that the first step in human ICT development is to bridge the gender divide within the Arab world and make use of the latent 50% of the Arab population.

The Arab world has the lowest Gender Empowerment Measure (GEM) worldwide next to Sub-Saharan Africa. Nancy Hafkin and Nancy Tagger (2001), in their study "Gender, Information Technology, and Developing Countries", stated that the degree of gender bias can be vividly seen across the Arab region. Figures indicate that Arab users constitute 4% of Internet users in comparison to 22% of users in Asia, 25% in Europe, 38% in Latin America, and 50% in the United States.

Hafkin and Tagger (2001) concluded that several challenges of socio-cultural, political, economic, and education disparities need to be addressed towards advancing Arab women's active participation in the new networked information society.

BACKGROUND

ICT Diffusion in the Arab World

The Arab world is generally known as laggard in adopting and utilizing new technologies, and ICT are no exception. The Internet first arrived in the Arab world in 1992 when Egypt established a 9.6k network connection through France. Next, several Arab states started joining the new networked world; however, the pace of ICT diffusion in Arab states was slow for various reasons (El Gody, 2003; Nour, 2002). To many Arab states, like Libya and Sudan, ICT are seen as the new arm of colonization; to others like Saudi Arabia the question of morality and culture perseverance hindered full adoption of the new technologies; to the rest, the fear of Internet liberal power on the authoritative regime stood against ICT adoption, as in Syria and Tunisia. That is why Arab countries took several measures to control ICT

Table 3. ICT control in the Arab world

Country	Laws & Regulations	Content Filtering	Tapping & Surveillance	Pricing & Taxation	Infrastructure/ Telecom Control	HW/SW Manipulation	Self Censorship
UAE		✓			✓	✓	
Bahrain		✓	✓	✓	✓	✓	
Kuwait		✓		✓	✓	✓	
Lebanon	✓	✓		✓	✓		✓
Qatar		✓	✓	✓	✓	✓	
Saudi A.		✓	✓	✓	✓	✓	✓
Syria	✓	✓	✓		✓	✓	✓
Jordan	✓		✓	✓	✓		✓
Oman		✓		✓	✓		✓
Libya		✓	✓		✓	✓	
Algeria		✓	✓		✓		✓
Egypt	✓				✓		✓
Tunisia	✓	✓	✓		✓		✓
Yemen		✓	✓	✓	✓	✓	✓
Palestine		✓	✓		✓		✓
Sudan		✓		✓	✓	✓	✓

Source: El Gody, 2003

Table 4. Internet/PC development in the Arab world

Year	Number of Internet Users	Number of PCs
1994		400,000
1996	640,000	900,000
1998	1,000,000	1,800,000
2000	1,800,000	3,400,000
2002	3,700,000	6,100,000
2004	5,200,000	11,300,000
2005	9,000,000	18,000,000
Exp. 2007	25,000,000	42,000,000

2005 — Gender Distribution (%)

Male	Female
96	4

2005 — Age Distribution

Age	%
U-15	7
16-21	42
22-35	31
36-50	16
50+	4

2005 — PC/Internet connection

Place	%
Home	29
Work	58
Cyber Café	12.7

Source: El Gody, 2003

(as seen in Table 3), ranging from imposing laws and regulations, telecommunication infrastructure control, content filtering, hardware/software manipulation, and tapping and surveillance (El Gody, 2003).

After a slow start, realizing its power, ICT diffusion has increased significantly (as illustrated in Table 4). A forecast by the Ajeeb Research Unit (Ajeeb Internet Surveys, 2006) estimates that the Arab world will experience a further increase in ICT demand, accelerating from about 9 million users in 2005 to about 25 million by the end of 2007 (Nour, 2002).

However, the level of ICT adoption in the Arab world cannot be assumed homogeneous (as seen in Table 5), as Arab countries and societies differ greatly in educational standards, financial strength, and willingness to innovate (Hafkin & Tagger, 2001). The level of political acceptance of the new medium also varies. The United Arab Emirates has the highest penetration rate in the Arab world with 24% of the population having access to ICT: Bahrain and Kuwait are a distant second and third, with penetration rates of 18% and 15%, respectively. Sudan, on the other hand, has the lowest Internet penetration rate of 0.05% (Nour, 2002).

Diab Hassan (2003), in his article "ICT Capacity Building", states that ICT in the Arab world grew by 250% between August 2001 and January 2004. While Gulf State countries like UAE, Qatar, and Kuwait possess the financial strength and state-of-the-art technologies to promote ICT infrastructure, the number of ICT users is growing more slowly in some countries, like Algeria and Sudan, which have fewer economic capacities (Hassan, 2003; Nour, 2002).

Table 5. ICT in the Arab world

Country	GDP	Population Using Internet	% of Population Using Internet	# of ISPs	# of Cyber Cafés	% of Population with Access to Telephone Lines	% of Population with Access to Mobile Lines
UAE	22000	1,200,000	24	1	200	48.8	39.6
Bahrain	16,000	200,000	18	1	140	23.5	21
Qatar	10,000	110,000	13	1	100	21.1	19
Kuwait	15,000	460,000	15	3	300	21.8	33
Saudi A.	10,500	1,400,000	3	44	2600	48.8	39.3
Oman	7,700	120,000	4	1	150	7.7	18
Yemen	1,000	25,000	0.3	1	100	1.1	1.6
Palestine	1,900	110,000	0.4	1	50	11	9.2
Jordan	3,500	300,000	4	7	3500	7.8	4
Lebanon	5,000	400,000	7	26	650	19.3	16.4
Syria	3,100	80,000	0.3	1	300	7.8	2
Egypt	3,600	3,300,000	4	67	6000	21	4
Sudan	1,000	25,000	0.05	1	70	1.1	1.6
Libya	8,900	80,000	0.5	1	400	7.25	4
Algeria	5,500	100,000	0.8	1	100	7.8	1.2
Tunisia	6,500	500,000	3	1	600	6.7	1.8
Morocco	3,500	500,000	1	1	2150	9.4	3
% Gulf to rest of Arab World *	76%	45%	83	43	38	67	76

*Note: * Percentage of penetration of mobile lines in Arab countries*
Sources: NUA, 2006; Ajeeb, 2006; Arab Advisors Group, 2003; Nour, 2002

Also, despite the recent overall positive growth trend, the market for ICT is still limited in most Arab countries, and this is apparent in the low demand, limited supply, and restricted ICT spending and investment. The Arab world embraces more than 300 million people, but as Table 5 indicates, the average share of the population having access to main telephone lines, mobile phones, or the Internet are 18.1%, 16.7%, and 5%, respectively, which are low in comparison to the rest of the world. Moreover, the average Arab countries' supply, as indicated by the average number of Internet service providers (ISPs), is very low as well (Hassan, 2003; Nour, 2002).

This limited supply is attributed to inadequate investment and infrastructure. ICT spending, ICT variables, ICT per GDP, and ICT per capita in the Arab world are minimal ($850 million) in comparison to the world average ($3.2 billion). Moreover, software-to-hardware spending ratios are lagging far behind the world's average (Dutta & Coury, 2003; Hafkin & Tagger, 2001).

From the discussion it is clear that ICT diffusion in the Arab world is still characterized by a market concentration in the richer Gulf countries and the wide digital gap between them and other Arab countries in terms of demand, supply, price, and services. That is why analysts believe that despite the recent growth in the ICT sector it still has a very limited effect in bridging the digital divide because developments are made only on the micro level, not yet touching the core issue, human development.

That is why, as previously mentioned, the first step towards narrowing the digital divide is by addressing developing Arab society. That is why the issue of women using ICT is important in today's world, to empower the Arab world.

FUTURE TRENDS

Women's Usage of ICT: Barriers and Means of Empowerment

Discussing women's empowerment means mainly discussing bridging the internal digital divide. Most women in Arab countries are in the deepest part of the divide. This divide is caused by different factors that need to be "empowered" (Egyptian Ministry of Information and Communication Technology, 2004).

Illiteracy and Education Empowerment

The single most important factor in hindering women's ability to take advantage of ICT opportunities is illiteracy. One out of two women in the Arab World is illiterate, making Arab women's illiteracy lowest next to Sub Saharan Africa. The illiteracy rate ranges from 16% in Morocco to 74% in Yemen (El Gody, 2004; El Zu3abi, 2003). Accounting for a higher English illiteracy rate, 80%, and computer illiteracy, we can see why ICT penetration is low among Arab women (El Gody, 2004).

During the past decade, Arab governments focused on providing access to basic education for girls; however, ICT needs to be integrated into the educational programs. This should help improve both the quality and reach of basic education to women (Wheeler, 1998).

Culture Empowerment

Arab culture does not accept new technologies or their diffusion easily within its system. The fast spread of ICTs made Arab governments worry about the outcome and their effect on the rigid Arab culture that is highly motivated by religious ideals (El Gody, 2003).

Religion is a major factor in shaping Arab culture. For centuries, male-dominated culture leans on religious traditions as an excuse for women disempowerment (Mianai, 1981). However, Hassan (2003) stated that Islam has nothing to do with women's disempowerment, discussing that both the Koran and the teachings of Prophet Mohamed emphasized that "acquiring knowledge is an ongoing duty on each Muslim from the cradle to the grave" and that "the quest for knowledge and science is obligatory for every Muslim man and woman." Hassan concluded that Arab authoritative governments are using religion as a tool to further women's disempowerment.

When ICT arrived, most Arab governments feared the liberalizing power of the ICT; for that reason, Arab governments used their media arms to hinder ICT diffusion within their societies. Discovering ICT benefits, Arab governments started to shift gears, increasing ICT culture awareness among societies calling for more women participation. Arab women created ICT societies that developed into the ICT Arab Regional Women Task Force (ICT/ARW-TF) (Abdel Latif, 2004).

Political Empowerment

ICT is a powerful tool in improving governance and strengthening democracy. It can be particularly useful for giving a voice to women in Arab developing countries that have frequently been labeled isolated, invisible, and silent (Hafkin & Tagger, 2001).

ICT can help empower Arab women's political participation, especially in changing women's image from the silent partner in the development process. ICT, especially Internet technology, can be used as a tool for women to create virtual networking groups to discuss socio-political issues, strengthen women's participation in the political process, increase women's access to government services, improve the performance of elected women officials, and disseminate political knowledge (Egyptian Ministry of Communications and Information Technology, 2004).

Economic Empowerment

ICT can assist women's economic development, even in rural areas. ICTs can improve women's activities in "farming, rural trade, business, and industry in a variety of ways ... for instance, female farmers could greatly increase productivity with access to information on improved agricultural inputs, weather, markets, new production techniques, and farming technologies" (Hafkin & Tagger, 2001).

Infrastructure Empowerment

One of the major problems hindering ICT development is the poor Arab telecommunication infrastructure that hinders the widespread reach of ICTs, especially in rural areas where more than 60% of Arab women live (El Gody, 2003).

Therefore, increasing women's access to ICTs involves increasing the availability of communication in areas where women live. Extension of infrastructure, particularly wireless and satellite communications, is crucial to this process. In addition, access efforts should focus on the establishment of common use facilities such as telecenters, community phone shops, and other public places convenient and accessible to women (Abdel Latif, 2004).

CONCLUSION

While most Arab countries are succeeding in narrowing the digital divide on the technical level by increasing ICT investments, the internal social divide, especially gender inequality, still blocks efforts to bridge the digital divide. Various challenges are still affecting women's active participation. That is why Arab stakeholders—governments, NGOs, international communities, and donors—need to unify their efforts in bridging the internal gap.

Recommendations: Towards Women's Active Participation

Assuring Women Access to the Information Society

It is crucial to increase women's access to ICT issues and allow them to be aware of the potential impact on women. This can be attained through introducing "tailored" programs for promoting awareness of the role of women in information society and circulating them among all countries of the region which will benefit from the experiences, activities, and initiative of specialized organizations.

It is also mandatory to motivate and encourage local and regional mass media to actively participate in spreading ICT awareness among women, especially in remote areas. Producing audio-visual media techniques is also important to facilitate women's access to information society.

Increasing Arab Government Participation

Arab governments need to include the issue of women and ICT in their national strategic plans. This can be attained through setting up committees or assigning a national body to follow up the issue of women and ICT at the national level. Arab governments need to adopt clear policies to promote and develop the information society and assure women's access and active participation.

Arab Women's Participation in ICT Decision Making

Arab governments need to be committed to the WSIS Declaration of Principles issued in 2003 that states women are "an integral part and a fundament element of the information society which should enable women to fully participate in all processes of decision-making." Arab governments and national bodies need to associate women's organizations in making national ICT policies.

Call Arab Countries to Initiate Programs to Educate Women on ICT Issues

Arab governments need to prepare ICT training programs aimed at women, with a special focus on marginalized population sectors, to promote ICT skills. Arab countries need to use existing regional initiative training programs aimed at training Arab women. This should be followed by an increase of funds allocated for research and development in the Arab region to maximize women's usage of ICT.

Creating More ICT Job Opportunities in the Information Society

All stakeholders—government, private sector, and NGOs—need to increase job opportunities to women in the field of ICT, giving more room for female creativity, design, and production.

Creation of Regional and International Cooperation Network

Arab women, especially in rural and remote areas, need to create regional and international "gateways" to discuss issues mainly dealing with empowering ICT usage and current challenges.

Private Sector Partnership

Arab businessmen and women are urged to support gender ICT business initiatives, especially small and medium projects, increasing cooperation among them, and to connect their businesses with their counterparts worldwide.

The Role of NGOs in Women's Access to Information Society

Local and grassroots NGOs need to foster activities in the field of empowering women and ICT, encouraging regional cooperation and information exchange.

Promoting Arab ICT Programming

Since language is one of the major problems hindering the spread of ICT among Arab societies, Arab governments need to promote Arabic content Web sites, especially those useful to women.

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KEY TERMS

Digital Access Index (DAI): Value by access level for countries, where 1 is the highest DAI level. According to the International Telecommunication Union (ITU), most of the Arab world falls under the middle and lower access unit. The average of the Arab world is 0.40, which is considered middle to lower class.

Digital Divide: A social cultural issue which refers to the socioeconomic gap between communities that have access to computers, the Internet, and telecommunications and those which do not.

Gender Empowerment Measure (GEM): A composite index measuring gender inequality in three basic dimensions of empowerment—economic participation and decision making, political participation and decision making, and power over economic resources.

ICT/ARIE-TF: A regional Non-Governmental Organization (NGO) created for voicing Arab women ICT initiatives at the World Summit for Information Society. The NGO aims to play a role in promoting ICT among women in the Arab world.

Internal Digital Divide: A term which refers to the gaps that exist between subgroups within the same community or society due to differing levels of literacy, technical skills, or gender disparities.

Middle East: By the term Middle East, the author is focusing on Arab countries that are included in the Middle East region, with the exception of Turkey, Israel, and Iran.

Women Technology Empowerment: The term appeared for the first time in the UN's *World Survey on the Role of Women in Development* (1986) and was defined as a process that "entails much more than awareness of alternatives, women's rights and the nature of requirements. It involves the breakdown of powerful sex stereotyping, which prevents women from demanding their rights from positions of authority" (Sethuraman, 1998, p. 92).

ICT Sector Characteristics in Finland

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INTRODUCTION

The ICT sector is a newcomer in the Finnish economy. The pace of growth in the Finnish electronics industry was extraordinary over the 1990s. It led to an industrial restructuring in which knowledge replaced capital, raw materials, and energy as the dominant factor in production (Ali-Yrkkö, 2001). The Finnish ICT company Nokia is a world leader in mobile communications. Nokia connects people to each other and the information that matters to them with easy-to-use and innovative products like mobile phones, devices, and solutions for imaging, games, media, and business. The net sales of Nokia totaled •29.3 billion in 2004. Nokia provides equipment, solutions, and services for network operators and corporations. The company has 15 manufacturing facilities in nine countries, and research and development in 12 countries. At the end of 2004, Nokia employed approximately 55,500 people. Nokia is a broadly held company with listings on four major exchanges (http://www.nokia.com). While Nokia's role in the Finnish economy is considerable, there is a large number of other actors in the ICT sector: hundreds of small and medium-sized, fast-growing companies networking and cooperating with Nokia. The strong ICT sector is largely the outcome of mutually enforcing, dynamic cluster relations, which were intensified during the 1990s. ICT managers are mainly engaged in developing software. The work is largely connected to projects in which suitable applications are developed for customers' needs. Applications are usually designed through interaction with customer representatives and software developers (Heilmann, 2004). The customers and the users of ICT in Finland are both women and men, but the majority of the workforce consists of men.

At the customer's side, there are many female ICT professionals. We can have a meeting where there are more women than men, and these women are really capable.

This article considers, first, background information about the ICT sector. Then information-technology companies are analyzed as sites for women's work. Future trends and needs of research are examined next, and finally the conclusion is presented.

BACKGROUND

While Finland is highly dependent on its two main business sectors, forestry and ICT, the attractiveness of the sectors, career development in the businesses, and their future developments are interesting fields of study. The second sector (ICT) is a newcomer, and the first one (forestry) has a long history. ICT has meant for many small economies like that of Finland a possibility for growth and development. The infrastructure in Finland is also recognized to be highly supportive for sector development because of good expertise backgrounds, schooling, adult learning, and state support. Does it attract women and men equally, and what will be its attractiveness in the future? Do women and men advance in the field in similar ways?

This study is comprised of two primary forms of research: literature on the ICT sector's development and empirical interview data gathered in 2002. The interviews were held with 15 ICT managers in Finland, including 2 females and 13 males. The average age of the ICT managers was 34.13 years. The managers were highly educated; 73.3% of all the managers had an academic degree, mainly that of a master of science in technology. Twenty percent of ICT managers were undergraduates in a technical university (Heilmann, 2004).

When compared with the paper business sector (producing pulp, paper, and paperboard), an older Finnish business sector with a long tradition, typical of the ICT sector seems to be the importance of networks, team working, and togetherness between workmates, even during leisure time (Heilmann, 2004). These characteristics also guide work advancement and have an impact on career development.

MAIN THRUST OF THE ARTICLE

The ICT sector can be characterized as a cluster. Clusters are used to describe networks of organizations in which competitive advantage grows from the dynamic interaction between the actors. Cluster relations cross the boundaries of sectors and spur innovation and upgrading through spillovers and knowledge transfer. A cluster can also be defined as a "network of networks," which has economic importance at the macro level (Ali-Yrkkö, Paija, Reilly, & Ylä-Anttila, 2000). The network dynamics cause positive effects on companies' competitiveness. The information and communication cluster, based on competence and technical development, has been able to offer new job opportunities, even if the time for the most rapid growth seems to be over.

In Finland, the main areas of the ICT cluster are the manufacturing of communications equipment and service provision. These areas have increased their share in the information and communication cluster (Hernesniemi, Kylmäläinen, Mäkelä, Rantala, Rautkylä-Willey, & Valtakari, 2001). Around the key industries there are industries that are considered to harbour special potential in enhancing the competitive advantage of the system through innovative applications on ICT, or though the improvement of its functional preconditions (Paija, 2001). The growth of the ICT cluster is not only connected to the growth of the markets in question, however. It is also connected to the general rise of the technical level in production and society (see Koski, Rouvinen, & Ylä-Anttila, 2001).

Careers in the Finnish ICT Sector

Because the ICT industry went through a very dynamic expansion during the 1990s, there was an especially big demand for young ICT professionals who had not only the necessary technical skills, but who could also understand the needs of customers within the new economic environment (Ruohonen, Kultanen, Lahtonen, Liikanen, Rytkönen, & Kasvio, 2002). Universities and research institutes have been successful in producing competent human resources and world-class research and development to support the development of the cluster. The supplier industries, particularly the electronics industry, in turn, have become highly specialized over the last decade to meet the needs of the key activities of the sector. The venture-capital market, as an example of associated services, has emerged as a new and important source of funding that has greatly enhanced preconditions for growth in the cluster (Paija, 2001).

The concept of career has been changing. Career progression has typically meant vertical advancement within one or more organizations, but nowadays it often describes lateral movements within an organization or from one company to another (Stroh & Reilly, 1999). Women should cope with the changing career environment, and within ICT, this means an increasing importance of the role of professional networks in career advancement.

In the future, the software sector will grow from a "nerdy" business into a professional business. Diverse skills relating to internationalization, especially experience in business management associated with international trade; language skills; negotiation skills; and knowledge of different cultures and administrative bureaucracy will be in great demand. In terms of personal skills, visionary capabilities, the ability to perceive matters in their entirety and to concentrate on essentials, communication skills, project and teamwork skills, adaptability, the ability to manage change, creativity, and courage will be emphasized. Strategic expertise will focus especially on network-related capabilities and on understanding the changes brought by the new economy and value chains within the digital economy. Eclectic scientific knowledge, the ability to integrate and master international networks and teams consisting of persons with diverse skills, creativity, and the ability to visualise and innovate are needed (for future developments in the field, see Hernesniemi et al., 2001; http://www.etla.fi).

The need for wider and multifaceted competence in the software business is increasing. In addition to software-based technical and product competence, there are business- and marketing-competence needs. Knowledge of law, international competencies, and an understanding of the meaning of production based on customer needs are all essential. There is also a need for comprehensive understanding of new challenges and opportunities created by the network and digital economy. Basic technical competence in the area of programming (e.g., skills of C++ and Java-programming languages) will remain important. In addition to these competencies, the demand for general and personal competencies will increase. In addition to personal learning, the strategic learning of the organization and strategy management connected to it will increase (Rautkylä-Willey & Valtakari, 2001).

Finnish ICT Sector as a Site of Women's Work

The ICT sector is a sector of young men; in over half of the Finnish ICT companies, the majority of employees are males under 35. Only in one out of four Finnish companies generally is the personnel as young as this (Kandolin & Huuhtanen, 2002; see also Heilmann, 2004).

The ICT managers mentioned in the doctoral dissertation of Heilmann (2004) were mainly engaged in developing software. The work was connected to projects in which suitable applications were developed for customers' needs. Applications were designed through interaction with customer representatives and software developers.

According to Heilmann (2004), it seems that the manager should be self-assured in managing his or her workload and working time. Interesting tasks involved with ICT work may cause an individual to get carried away and can easily steal too much time from his or her life. He or she should be aware and conscious of how to divide the hours of the day between work and leisure. Many managers have recognized the need for rest and have managed to adjust their work schedules. In recent writings, the need for rest and play in the ICT sector has been emphasized (see, e.g., Kivimäki-Kuitunen, 2000). It is obvious that younger workers will want to commit extra hours to work in order to demonstrate their abilities and competence, and ascertain future employment and career possibilities in the organization. In the interviews, both managers and employees agree upon the importance of rest and recreation and also call for flexibility. When private life needs more time from the manager, then he or she is allowed direct time toward the family. On the other hand, the family gives way to business when needed. It seems to be the birth of children that makes the division of work and leisure more clear. It is not possible to work long days anymore if one wishes to stabilize life (Kivimäki-Kuitunen). In a networking work environment, this is a challenge, especially for those women with family duties.

Within this sector, production can be defined as a purely masculine area. ICT-sector professions require mathematical skills, and girls usually choose something other than mathematics to study at school. There are ever fewer female students in technical universities. This is the main reason for the scarcity of females among the technical professions, but in the interviews of male ICT managers, there were found also attitudes that favoured males and showed suspicions about the competence of women (Heilmann, 2004).

In the interviews, it was still stated that gender does not seem to have great importance in developing software; what is more important is how capable the person is. Women are welcomed into the ICT sector by men: The representation of both sexes in the working place was said to have a good effect on the working climate. Concurrently, the managers mentioned there was a lack of female workers and managers in the ICT business (Heilmann, 2004).

Women in the ICT sector seemed to work mostly on supportive assignments like testing and documentation, or as assistants (Heilmann, 2004). There are signs that women in the ICT business have accepted the masculine world and made themselves "good guys." Even if the individuality of workmates was emphasized, in the interviews there was often a clear separation between women and men of the workforce:

Women work in documentation. Only one of them works in production. I see no difficulties. They are very nice girls. (ICT manager, male)

It seems that gender matters do not have much importance in work situations. Anyhow, women notice the existence of the “glass ceiling” in their career development. The career progression of women usually stops at middle management. However, the men managers did not consider the concept of the glass ceiling in the interviews (Heilmann, 2004).

Networks in the field seem to be gendered with the dominant role of men. This is clearly recognized by the female interviewees, even if they seem to have found their own ways to cope with the situation.

I feel comfortable working with men here. I have worked a lot with them. They have taken my job positively. I think there exists some kind of glass ceiling for women, however. It doesn’t bother me. I have a nice job. But there exist many men’s affairs when men do things together. Other department managers are taken along more easily because they are male. I don’t know if they think that it would be difficult if a woman goes along. Boys can’t talk boys’ business then. Actually, I notice it only when I start thinking; it doesn’t bother me every day. (ICT manager, female)

In my first job the male colleagues helped me a lot. It was very nice. Both in personal relations and work occasions they have treated me very well. From customers’ side and from everywhere else it is the same. I have been privileged to be in these work situations as a woman. Sometimes, in the situations where male outsiders are present and where I have not been before, males talk like there is not any female present. They do not pay any attention to female members of the group. But now when I am already older and gained competence, they listen. (ICT manager, female)

I don’t think gender matters at all. Almost a half of my team members are female. When you look at the organization chart you see more males in upper levels of this organization. It would be nice to have there more females. (ICT manager, female)

Also, the male managers of ICT are aware of the gendered nature of their work environment.

There could be more women working here. I don’t know; maybe it comes from different hobbies. Boys and girls do different things. Boys have always been interested in machines, computers, and so on. (ICT manager, male)

Secretaries have always been female, but I see that this workplace is equal for both sexes. (ICT manager, male)

This gender structure works here. The secretary has always been female, but there are five or six other women working in our organization as well. Mostly they work in documentation; only one works in production. There isn’t any harm of them; they are nice girls. Of course, when you have to arrange some company events with a sauna, you must divide the personnel into males and females. But it happens everywhere; there is no trouble. But from a professional point of view I don’t see any trouble. (ICT manager, male)

In the interviews, male managers raise female gender as a problem in terms of its minority, not so much professionally. However, the female workforce is not recognized as a source for creativity among male ICT professionals. Diversity is emphasized as a value as such in the working environment. Also, the customers in the ICT sector are both women and men.

FUTURE TRENDS AND NEEDS OF RESEARCH

Information professionals are rapidly increasing not only in numbers, but also in respect to modern companies’ needs for development, which places new demands on compensation and career-development policies. Both women’s and men’s work are valuable, partly because customers’ needs are gender dependent. Customers’ needs should be understood better and studied if there is also a gender gap to be filled.

This work environment is not so one-sidedly male because on the customer side, there are also many women. Women are often even in the majority in meetings. (ICT manager, male)

Companies are still facing a clearly exceptional labour-market situation in which there is a continuous shortage of competent information professionals. The attractive labour market and biased compensation structure risks the commitment of professionals and leads to high turnover rates. As a result of this, not only company attractiveness and the working climate need to be developed, but also exceptional recruitment methods need to be introduced. Due to the pace of technical advancement, the developmental needs of information professionals are on a scale of their own. With the aging workforce, this challenges the human-resource development and career planning of the company. Because of scarce human resources, heavy workloads, and developmental needs, work exhaustion prevails, which in turn calls for the application of new and flexible working practices (Holm, Lähteenmäki, Salmela, Suomi, Suominen, & Viljanen, 2002). The combining of work and private life with family responsibilities should be taken as a serious challenge of ICT companies' human-resource management. Women and also young, family-building-aged men can benefit from this kind of support.

The Finnish ICT sector is very network based, and this is a special challenge for women who are a minority with not so many contacts in the field. Networks are often gendered by nature, involving a lot of unprofessional meetings. This evidently edges out women professionals and might hinder their career advancement within the workplace. The meaning of networks should be studied as well, from the angle of how both sexes can take advantage of them and what this means to the development of the field in general. The meaning of soft work is increasing in the field, and the sector will acquire multiskilled competence in the future.

CONCLUSION

ICT companies seem to be very masculine environments. Among men, there exists some kind of suspicion toward women's competence in the area of information and communication technology. Women's tasks are usually connected to lower level or supportive assignments, and their career progression may stop at the glass ceiling. Concurrently, the existence of both sexes in ICT companies is appreciated, but its importance for the well-being of companies is not recognized.

This is a masculine environment. There could be more girls here. It forces boys to shape up when a girl sits at the same table. I haven't met any good female software developers, but I know they exist. It is possible for girls to develop software, though it is a technical area. (ICT manager, male)

It looks as if there is a double gaining of expertise for women of the ICT sector. The first is in the school years when technical competence is acquired. Basic competence is based on mathematical skills and education first in the secondary school, and after that in technical universities. So the ICT sector becomes a masculine world from the beginning of education. After the gained formal education, competence is developed toward more specific know-how expertise inside the ICT companies and by lateral movement between the companies. Work traditions, company cultures, and networks should take better account of the gendered nature that they carry and invite competent and highly motivated women and men to enter and advance in the field. In the future, technical skills will not be enough for competence, and women can therefore enter at least into the first expertise level more easily than before.

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KEY TERMS

Gender: Gender refers to the cultural construction of femininity and maleness.

ICT Business Sector or Software Sector: Produces software applications. It hires young employees and is vulnerable to changing economic conditions.

ICT Cluster: ICT-cluster relations cross boundaries, but it mainly includes the manufacturing of communications equipment and service provision. It can also be defined as "a network of network managers". It involves producing software, but also involves supporting related industries, associated services, and buyers and appliers.

Manager: A person working in the middle level of an organization. He or she plans, organizes, motivates, directs, and controls.

Network Relations: The social, economic, and often informal relations that construct a business sector or a cluster.

ICT Usage in Sub-Saharan Africa

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INTRODUCTION

Given the circumstances of women's lives in *sub-Saharan Africa*, it may appear that *information and communication technologies* (*ICTs*) are only for wealthy, well-educated, urbanized women with time to use them, and that they are irrelevant for other women in sub-Saharan Africa. However, this is not the case: women see ICTs as providing opportunities for change, by giving them access to the information which will help improve their circumstances, as the abundant research shows (Hafkin & Taggart, 2001; Huyer & Mitter, 2003; Morna & Khan, 2000; Pacific Institute of Women's Health [PIWH], 2002; Rathgeber & Adera, 2000).

This article presents an overview of women as ICT users in sub-Saharan Africa, covering the challenges and the success stories. Since there is a large body of literature covering this area, only a representative subset is surveyed. The focus here is usage. Information technology (IT) professionals and more technological topics are considered elsewhere in this volume. Much of the literature about usage in developing countries takes a broad definition of ICTs because of the lack of the latest technologies. For example, Holmes (2004) includes computers, the Internet, mobile phones and wireless technologies as well as telephone, radio, television, print media, listening groups, and community theatre. This article will consider all electronic technologies, from computers and networking to radio and television.

When considering ICTs and developing countries, the *digital divide* is often mentioned. This term is sometimes used specifically to refer to the Internet; for example, see DiMaggio, Hargittai, Neuman, and Robinson (2001). In line with the broad definition of ICTs given above, in this article, the term *digital divide* will be used to refer to inequality in access to ICTs and ability to use them. There are multiple divides: men vs. women, urban vs. rural, rich vs. poor, young vs. old, developed vs. developing. When considering developing countries, there is an underlying information divide—people do not have access to information sources they require, electronic or otherwise, due to poverty and lack of infrastructure. This is the real problem that needs to be solved—ICTs are a means to this end.

BACKGROUND

Sub-Saharan Africa has a population of 641 million where only 35% of the population lives in urban areas, and almost half of the total population is under 15 years of age (United Nations Development Programme (UNDP), 2004). 32% of the population is undernourished, 323 million people live on less than $1 per day, and it is estimated that 8% of the population is HIV-positive; the UNDP Human Development Index for sub-Saharan Africa has decreased during the 1990s, showing the effect of the HIV/AIDS epidemic (UNDP, 2004).

All of the countries in sub-Saharan Africa are classified as developing. Thirty-one are classified as *least developed countries* by the United Nations (UN). There is a large need for development—a legacy of the history of slavery and colonialism which has affected the region. Progress has been made; for example, the adult literacy rate is 63% compared to the youth literacy rate of 77% (UNDP, 2004) which indicates that access to education is increasing. Clearly there are differences between countries; Mauritius, South Africa, and Nigeria, for example, have less poverty, although they have large wealth disparities within their populations.

In terms of technological infrastructure, there are only 15 landlines, 39 cellular subscribers and 10 Internet users per 1,000 people (UNDP, 2004). Rural areas are less likely to have electricity than urban areas, so battery, solar-powered, or wind-up radios are prevalent.

Status of Women in Sub-Saharan Africa

Women's lives in sub-Saharan Africa are influenced by strong societal opinions about their roles including an expectation that they will focus on the home, and they have less access to education and health than men do (Huyer, 1997; Momo, 2000). The female adult literacy rate is 54% compared to the male adult literacy rate of 70%; and the female youth literacy rate is 72% compared to the male youth literacy rate of 81% (UNESCO, 2004). The gross enrolment ratio at primary level is 78% for girls, and 91% for boys; at secondary level, 24% and 30% (UNESCO, 2004).

The contribution of women in terms of housework, child-rearing, subsistence farming and community management is not valued in a cash economy, and hence overlooked (Huyer, 1997). This contribution is important, and women often want to use ICTs and other information sources to improve the conditions of their families and communities. However, because of women's multiple roles, time is limited, hence the time taken to seek out information must balance with the gain achieved (Huyer, 1997).

ACCESS TO ICT

Access to ICTs is low. In 2000, women made up 12% of Internet users in Senegal, 32% in Uganda, 38% in Zambia and 51% in South Africa, but the number of Internet users in these populations is small, hence few women have access (Hafkin & Taggart, 2001)

Some of the obstacles to use of ICTs by women are low levels of literacy and education, lack of materials in local languages, lack of time, inconvenient opening times for public ICTs, cost, safety issues, sociocultural expectations about women's roles and movement in public areas, and lack of skills in using ICTs (Hafkin & Taggart, 2001). These barriers do not just occur because of poverty; they are amplified by the second-class status of women (Hafkin & Taggart, 2001).

Education is crucial; Amolo Ng'weno notes that a high school education is required to use the Internet effectively (Carnevali, 2002). With low rates of secondary education, access alone is not sufficient. The HIV/AIDS epidemic is also an issue; girl children are more likely to be removed from school to care for sick relatives, and teacher numbers are decreasing significantly (Isaacs, 2002).

Education

Few schools in Africa have access to ICTs, and to date little research has been done. Isaacs (2002) highlights the fact that many *SchoolNet* projects do not consider gender, and this may affect how successful they are for girls. The introduction of ICTs in education may be both positive and negative. In Africa, women are a substantial number of those studying by (non-computer-based) distance learning because learning can be fitted around domestic activities, and Derbyshire (2003) suggests that the introduction of computer-based distance learning could impact the number of women studying if they have no or limited access to computers, although it could also increase their interaction with other learners.

The World Links program was found to have positive aspects for girls. This program placed computers with Internet access in schools in Senegal, Mauritania, Uganda, and Ghana. Gadio (2001) reports that in all countries, teachers felt that girls gained more academic benefit from usage because of their focus on academic material. The girls also reported increased self-confidence, and the opportunity to obtain information about health and sexuality that is not available otherwise. However, in Uganda and Ghana, girls had less access due to after-school chores and social prohibition on running which prevented them from getting to the labs before boys. In comparison to boys, no girls took part in maintenance of the labs, even at single-sex schools, although at one school, the girls used their skills to teach primary-level children about computers, which appears to indicate a lack of interest in maintenance rather than lack of confidence with computers.

Public Access

Telecenters have been proposed and implemented as a way of achieving access to telephones and other ICTs. Additionally, in many cities in Africa, commercial Internet cafes are becoming common (Levey & Young, 2002; Mbarika, Jensen, & Meso, 2002).

Cost is an issue, and unless telecenters are heavily subsidized, they are unlikely to be affordable for all (Morna & Khan, 2000).

Telecenters are not always successful for women since it is often assumed that users will find their own way once the technology is provided (Rathgeber, 2002). Urban women were more likely to use telecenters, and usage typically did not include fax, Internet, or e-mail (Rathgeber, 2002). Rural women found telecenters problematic due to their cost, inconvenient opening times, plus perceptions that they are for men and have no material for people who are illiterate (Women'sNet/Dimitra, 2004).

In Uganda, 29% of users were women, in Mozambique 35% and in Mali 23% (Rathgeber, 2002); telecenters in Nigeria, Ghana, Ethiopia, Uganda, and Mozambique had fewer women users than men (Johnson, 2003). In contrast, the telecenter in Gaseleka in South Africa has a regular user community which is more than 60% female, the centre is managed by two women, and a basic computer literacy course had a majority of women graduates (Benjamin, 2001), showing that telecenters can be accessible to women. Some forms of public access are focused on women; for example, Isis-WICCE (http://www.isis.or.ug) opened an Internet cafe in Kampala, Uganda, which is a resource for women run by female staff, and which charges less than commercial operations (Oriang', 2002; PIWH, 2002).

Business

Many large companies in sub-Saharan Africa use ICTs including the Internet daily, but smaller businesses and entrepreneurs often do not have the resources. African business women want information about trade policies, fair trade, and ways to increase income, as well as ways to market products and communicate with purchasers (Huyer, 1997).

UNIFEM (United Nations Development Fund for Women) (http://www.unifem.org) is involved in programs about ICTs and business, including the WINNER Network (http://www.winner-tips.org) which is operational in Zimbabwe and imparts ICT skills to help participants in marketing their goods, locally and internationally. In addition, the Digital Diaspora Network links up Africans with ICT skills who live outside Africa with women's *non-governmental organizations* (*NGOs*) and business organizations for technology and skills transfer. This project will also provide business role models for African women (Carnevali, 2002). The South African Department of Trade and Industry has developed the Technology for Women in Business program (http://www.twib.co.za) to assist women in developing technology-based businesses. There are numerous other programs.

Telecenters are a source of business information, although research has shown that they are used by women mostly for social or family purposes (Rathgeber, 2002). An example of the material that can be provided is a Ugandan CD-ROM on earning money for illiterate and semi-literate women involved in subsistence farming who found it useful in making decisions (Mijumbi, 2002). The women of Twendelee Handicrafts in Nairobi, Kenya use Internet cafes to access Web pages about knitting (Oriang', 2002). Businesses also employ women in positions where computer use is required; particularly secretarial or data entry jobs (Hafkin & Taggart, 2001). With the trend for outsourcing, jobs involving ICTs such as call centre operators and data capture, are moving to Africa for cost reasons; for example, all environmental tickets issued in New York are captured in Ghana (Huyer & Mitter, 2003). A concern is the sustainability of these jobs, as they tend to be repeatedly relocated to where costs are lowest.

Development

ICTs play an important role in development, although there is often a perception that they should have lower priority than basic services such as clean water and education (Rathgeber, 2000). At a workshop on empowerment of rural women (Women'sNet/Dimitra, 2004), rural women from Africa emphasized the ability of ICTs to provide information that would enable them to improve their lives. Radio is the preferred medium because of its accessibility; telecenters were seen as less accessible and a solution proposed was to take material to women in their homes (Women'sNet/Dimitra, 2004).

An example of the role ICTs can play in development is the Pacific Institute for Women's Health project to improve communication by women's NGOs in Zimbabwe, Uganda and Zambia by providing e-mail and Internet access, and opening Internet cafes for women (PIWH, 2002). This fits with Kole's three-sector model of African society: the modern, non-modern and information sectors (Kole, 2003). NGOs that use ICTs can operate at the intersection of the three sectors, often enabling community-based organisations in the non-modern sector to use ICTs.

APC-Women has developed GEM (Gender Evaluation Methodology) (http://www.apcwomen.org/gem) as an online tool to evaluate the gender impact of ICT development initiatives. As noted earlier, there is a specific gender dimension to poverty, and the analysis provided by GEM allows for assessment of how a specific ICT project has improved women's lives.

FUTURE TRENDS

There are many important recommendations about the way forward: from the general, such as full and equal education for women at all levels and in all disciplines, improved healthcare and the ability to exercise human rights; to the specific such as ensuring that telecenters are accessible to women (Johnson, 2003; Momo, 2000; Rathgeber, 2002), equal access to computers in schools (Derbyshire, 2003; Isaacs, 2002), evaluation of the success of ICT projects in terms of gender, and appropriate use of technology for local conditions (Kole, 2003). The World Summit on the Information Society (WSIS) Gender Caucus (http://www.genderwsis.org) has identified key principles for the Information Society including gender as a fundamental issue, equal participation in decision-making, a combination of old and new ICTs, appropriate design of ICTs, and evaluation of the impact of ICTs on women. Marcelle (2001) notes that to achieve an African women's cyberspace, relevant content must be generated by African women, technology must be managed by African women, and interaction must occur between user and producer.

Gender should be part of national and international ICT policy (Hafkin & Taggart, 2001; Huyer, 1997; Marcelle, 2000; Morna & Khan, 2000) otherwise ICT projects may only serve part of the community. Groups such as APC-Women-Africa are involved in lobbying around these issues.

CONCLUSION

Development and reduction of poverty is one of the motivations for the use of ICTs in developing countries such as those in sub-Saharan Africa. ICTs are not a panacea—they can have both positive and negative effects, hence it is not sufficient just to provide ICTs though provision is one of the steps. An understanding of women's information needs, as well as of their lives is necessary to ensure the technology is provided in a way that is accessible, useable, and effective. Women in sub-Saharan Africa are seldom passive consumers of technology, but active participants looking for information and tools to improve their own conditions as well as those of their families and communities.

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KEY TERMS

Digital Divide: A term describing the gap between those who have access to and can use technology effectively and those that cannot. There are narrower definitions that focus on the use of the Internet, and broader definitions that include all ICTs.

Information and Communication Technologies (ICTs): Electronic means of communicating and conveying information, covering media such as radio and television, computer and computer networking technology and telecommunications. This is a broad definition of the term.

Least Developed Countries (LDCs): Countries identified by the United Nations as having a low GDP per capita (less than $750), low levels of health and education, and economic vulnerability. Thirty-one of sub-Saharan Africa's countries are classified as LDCs: Angola, Benin, Burkina Faso, Burundi, Cape Verde, Central African Republic, Chad, Comoros, Democratic Republic of the Congo, Equatorial Guinea, Eritrea, Ethiopia, Gambia, Guinea, Guinea-Bissau, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Niger, Rwanda, São Tomé and Principe, Senegal, Sierra Leone, Togo, Uganda, United Republic of Tanzania, Zambia (UNDP, 2004). The sub-Saharan countries that are not classified as LDCs are: Botswana, Cameroon, Congo, Côte d'Ivoire, Gabon, Ghana, Kenya, Mauritius, Namibia, Nigeria, Seychelles, South Africa, Swaziland and Zimbabwe (UNDP, 2004).

Non-Governmental Organizations (NGOs): An NGO is a non-profit organization focused on particular issues for the public good. It can operate locally, regionally, nationally or internationally, and it may provide services, lobby government or perform monitoring. Some of the NGOs involved with women and ICTs in sub-Saharan Africa are Women'sNet, South Africa; Isis-WICCE, Uganda; APC-Africa-Women, Zimbabwe Women's Resource Centre and Network, ENDA-SYNFEV and FEMNET.

SchoolNet: An organization focusing on access to ICTs within schools, network and Internet connectivity access, as well as content development. Most SchoolNet projects are small scale and donor funded (Isaacs, 2002). SchoolNetAfrica is an NGO supporting country-based SchoolNets in Africa (http://www.schoolnetafrica.net).

Sub-Saharan Africa: The area of Africa south of the Sahara. In terms of the United Nations definition, this covers all countries on the Africa continent excluding Algeria, Djibouti, Egypt, Libyan Arab Jamahiriya, Morocco, Somalia, Sudan and Tunisia, and covers the island states of Comoros, Madagascar, Mauritius, São Tomé and Principe, and

Seychelles, giving a total of 45 countries (UNDP, 2004). All countries in sub-Saharan Africa are classified as developing countries.

Telecenter: "[A] location which facilitates and encourages the provision of a wide variety of public and private information-based goods and services, and which supports local economic or social development" (Kanfi & Tulus, 1998, para. 2). A distinction can be made between telecenters which are community focused, and commercial Internet cafes or cybercafes.

ICTs for Economic Empowerment in South India

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INTRODUCTION

The role of new technologies, particularly information and communications technology (ICTs) in the global society is central to both contemporary social theory and understanding transformations that are characteristics of the information society and post modernity. The emphasis on technological determinism is useful in tracing social and economic changes at large, but the economic and social shaping of technology is often illustrative of wider social relations, with local considerations. Recently, studies have demonstrated how technology is socially-contextualised, with gender differential barriers to access and use of ICTs by men and women (Hafkin & Taggart, 2001). This article argues that ICTs as a form of new technology are socially deterministic, albeit context dependent, need to take into account the role of social actors and interactions, which is often ignored in the blind pursuit of market forces.

The article is structured as follows: the Background section examines some of the debates relating to gender and ICTs; then the Main Thrust section proceeds to examine the ICT context in southern India through a case study of the Kudumbashree project and some conclusions are provided in the last section.

BACKGROUND

Gender and ICTs in a Global Society

There have been a number of perspectives in understanding the social role of technology. The social construction of the technology is useful in analysing users as agents of technology and change, where a social (and logical) perspective is applied to scientific knowledge (Kline & Pinch, 1999). Often social groups, which are dynamic in nature, play a crucial role in the development of technological artefacts. The theoretical perspective on Actor Network theory developed by Strum and Latour (1999) reveals the mutual constitution of technology and society showing how these are not fixed social structures but are continuously and actively negotiating and renegotiating relative roles. The role of the social actors both at the macro and micro-level is important as well the social link in relations between various social actors. These social actors in an ethno-methodological fashion according to Garfinkel's social interactionism, are transformed from "cultural dopes" to active social actors (Mackenzie & Wajcman, 1999).

There has been a burgeoning body of literature in relation to the role of gender relations in technological change, demonstrating the masculine nature of technology and capitalist domination. Research in industrialised countries has noted that technical fields and IS systems are highly gendered (Wajcman, 2004; Webster, 2005) highlighting the social shaping, or constructivist, theory of technology. In looking at the socio-cultural influences on the professional development and working lives of women IT professionals, Trauth (2002), rejects the essentialist view of women and their relationship to IT that has been put forth in the information systems literature arguing, instead, the primacy of societal and structural influences.

Relatively little has been researched or written about the specifics of gender relations in the ICT sector in developing countries, although there are emerging studies in relation to call centres or the Software Industry (e.g., Arun & Arun, 2001) and it is this knowledge gap that this article partly addresses. It has been shown here that to analyse the deeper issues affecting women's engagement with ICTs we need to take a wider scope, such as the "gender & technology as socially defined" and "experience of daily life" approaches. It is clear from this overview that a gender perspective may take several forms varying from those focussing primarily on the individual as the means to bringing about change, to those taking a wider scope and attempting to transform the society and culture in which women are living. The Association for Progressive Communications (APC) brings the importance of women's involvement in the "definition, design, and development of new technologies" (APC-WNSP, 2002). The gender evaluation methodology (GEM) is grounded in the view that any gender analysis should (APC-WNSP, 2002) focuses on both self and social change: addressing the relationship between the ICT initiative and the way the "self" (individual, organisation, and/or community involved) operates and also the relationship between the ICT initiative and the broader context (social, political, economic, and cultural).

The experiences in one South Indian state—Kerala[1]—that can be seen as a microcosm of the ICT experience in India with a booming software sector as well as a number of innovative state interventions in ICTs, including *Kudumbashree*, a women-led poverty reduction programme that has made use of ICTs to enable the development of ICT-based enterprises run by cooperatives of poor women. In order to do this, a qualitative and case study based approach was undertaken in July-December 2004, with empirical research based on women as workers, women as entrepreneurs, women as social and economic agents in households and communities and discussion with key informants.

MAIN THRUST OF THE ARTICLE

Gender Shaping of ICTs in South India

The software and services component of the ICT sector has emerged as one of the fastest growing industrial segments, increasing from U.S. $170-million worth of output in 1991-92 to U.S. $8.8 billion in 2003-04 (Arun, Heeks, & Morgan, 2004). The state of Kerala in South India has formulated ICT policies, through increasing human capital, creating infrastructure and innovative strategies to use ICTs as panacea for poverty alleviation.

The Kudumbashree initiative is a state interventionist poverty eradication strategy, which strongly gender-focused. *Kudumbashree*—which means "prosperity of the family"—is an initiative of the Kerala State Poverty Eradication Mission (SPEM) was launched in 1999 as a women-oriented, participatory, and integrated approach to fight poverty (Government of Kerala, 2003). Thus, use of ICTs could help gain economic empowerment of poor women and households to tap into the broader range of relations between ICTs and enhanced social and economic development. Neighbourhood Help Groups (NHG) or *ayalkootams*—a type of cooperative of ten women from poor families (based on non-monetary indicators) are formed as the basis for each Kudumbashree unit. These micro-enterprise units include a range of activities from food processing, cleaning, handicrafts, but its most innovative aspects has been its use of ICTs to form the basis for some of its enterprises.

In all, 1,206 Kudumbashree units are now operational in a range of sectors (Kudumbashree, 2004) owned, managed and operated by women from poor families. Out of these, there are three types of ICT-based enterprise comprising of 45 IT training units which provide IT training to schools; 56 data entry and digitisation units which mainly create local digital content for public (and to a lesser extent private) sector organisations; and 5 hardware assembly/maintenance units.

A profile of these ICT enterprises is provided in Table 1, which illustrates that the main ICT activities relate to data entry, hardware assembly and servicing as well as IT training. The selected units are located in different region, from the main state capital of Thiruvanathapuram, in the southern region of the state, to both urban and per-urban areas in the northern region of the state. In all, there has been a sizeable employment impact, with the ICT units creating jobs for nearly 2,000 women; with nearly U.S. $50 is being earned by each member (Arun et al., 2004). The average number of members within

Table 1. An overview of Kudumbashree ICT micro-enterprises

	Hardware Assembly	Data Entry	IT Training
Name	InfoShree Systems	Technoworld Digitals	Divine Computers Vidyasree
Start Year and Location	2003, North Kerala (peri-urban)	1999, South Kerala (State Capital)	2002, North Kerala (Urban)
Activities	Hardware: assembly & service Data Entry & DTP work: Training	Data Entry--Digitalisation of Public Records; Training: Students	IT Training to High school students
Source of Finance	Bank Loan, Subsidy, & Group Contribution	Bank loan, Subsidy, & Group contribution	Bank loan, Subsidy, & Group contribution
Employment & Human Capital	10 group members, (Electronics and computing): Four employees (all men)	10 members, (PGDCA, DCA); one Male supervisor: 52 casual workers	six members (DTP, PGDCA and CTTC

Source: Fieldwork (2004); Kudumbashree (2004)

a group is 10, although training units have lesser numbers of members. In addition, employment is further provided to women and men from similar backgrounds, again demonstrating the welfare dimensions of the enterprises. There is also a genuine perception of the women themselves that they have been empowered; and as active agents in society, and as revealed from discussions, a number of women from the units having been participating in community level affairs (Arun et al., 2004).

Human capital is quite high among these entrepreneurs, despite belonging to economically poor families. On an average, women possess under-graduate and post-graduate degrees, with further technical qualifications in ICT such as electronics, Post-Gradate Diploma in Computer Applications (PGDCA) and Diploma in Computer Applications (DCA). On joining the enterprise, many have increased their capabilities in both computing as well as personal skills such as language, communication and business skills, and competencies in the ICT sector which is traditionally the preserve of men. In the Training Sector, some have gone on the gain teaching qualifications in computing, (i.e., Computer Teachers Training Course (CTTC)) which is seen as a very proud achievement as summarised by Preeta, the group leader from the Training Unit, “for women like me from both economically and socially deprived groups (in terms of caste), the status of a teacher is a dream come true.”

The main source of finance of these enterprises comprises of institutional loans, state subsidy and group contribution, all of which is facilitated by the Kudumbashree institution. Some units, like the Data entry Unit, started in 1999 has repaid all its loans and surplus funds are being diverted for reinvestment in the business, venturing up the value chain in specialised services such as Web designing. The main customer/client base for these enterprises is largely the state sector, enforced through supportive policies which include digitisation of all state records, provision of ICT infrastructure and equipment, increasing human capital of school students in ICT training, all which are to be provided through Kudumbashree units. It must be recognised that development of the Kudumbashree IT units has required a significant degree of institutional support from government departments, banks, other financial intermediaries, and other local organisations. In order that these enterprises run effectively and sustainable in the long run, and without much support, it is further crucial to formulate policies that support such small enterprises, in terms of both generic and specific needs of ICT-based enterprises for women.

CONCLUSION AND FUTURE TRENDS

Often the compelling nature of technological change is crucial in the economic shaping of technology, guided by economic factors and market competition ignored roles of social actors and interactions at both macro and micro levels. Social relations affect and shape technology, with a number of forces responsible to the economic and social shaping of technology, including the nation-state, markets, and other institutions. This article has presented case studies from South India that provides the basis for a qualitative and exploratory investigation of the ways in which interventionist ICT initiative, Kudumbashree, illustrate the capacity of gender-focused, locally-owned and participative–and for rather different outcomes.

Intervention certainly has its disadvantages and—despite the existence of these ICT-based enterprises for five years—questions are still raised about sustainability. The range of competencies developed is considerably greater because women have been allowed to break out of the traditional stereotypes of inequalities of power and responsibility and thus been able to make at least a start on breaking down some of the social, political, and even institutional bases of gender inequality as seen from a GEM perspective. The interventionist approach to using ICTs for women's development—as represented here by Kudumbashree—is by no means a panacea. It arises from a particular set of institutional arrangements and political priorities that cannot be wholly transplanted to other contexts, but needs to be adapted according to location specific characteristics. Some generic lessons are valuable from the Kudumbashree example, such as enabling policies and institutions and locally participatory nature of initiatives. It also pinpoints to the fact that choices of technological change (such as ICTs) and strategies are continuously shaped and renegotiated in local contexts as technological change is to be actively shaped rather than passively responded to (Mackenzie & Wajcman, 1999). In adopting a gendered perspective, the non-gender-neutral nature of technology, ICT engagement has to go beyond mere participation, with gender relations that are embedded in their environmental context.

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KEY TERMS

Ayalkootam: Self-help groups of around ten women from poor families.

Caste: Rigid social groups differentiated by descent in the Hindu Society.

Empowerment: Increased capability at various levels, (e.g., economic, political and social).

Kudumbashree: A poverty eradication programme aiming for the prosperity of Family through helping women.

Micro-Enterprises: Small enterprises, defined by size of investment, employment, and scale of business.

Panacea: Universal solution.

Vidyashree: Small enterprise units that undertake ICT training in Schools (*Vidya meaning education*).

ENDNOTE

1 Kerala rates relatively highly—as least compared with other Indian states—on various social development indicators (Parayil, 2000). In many respects, Kerala is seen to be a very particular model of development based on specific institutions, interventions, and historical processes (Tornquist, 2000).

The Impact of Gender and Ethnicity on Participation in IT

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INTRODUCTION

The excitement of information technology is not only within the discipline itself. Advances in computers have led to leaps in almost every academic discipline and changed the very nature of our everyday lives. The knowledge revolution has resulted in rapid changes to the way we work and live. This includes the offering of an increasing range of career opportunities that did not exist before. Computing is one of the fastest growing industries, but since most jobs remain dominated by males, women remain a major latent source of talent for the technology field.

BACKGROUND

Participation in IT

Information technology (IT) serves broad needs of society. The technology workplace should reflect the interests of both men and women. Assuming entry to the IT career domain is restricted by tertiary qualifications, female's low enrolment rate in computer related subjects would lead to ineffectual future workforce planning. A survey of the top 150 public hi-tech companies in the Silicon Valley found that only four had female CEOs (Raghaven, 2001). In the United States, the number of female computer science graduates has fallen from a 1985 peak of 35.8% to 27.5% in 1994 (Raghaven, 2001). The United States National Science Foundation (1999) statistics show that the proportion of women receiving bachelor's degrees in computer science dropped from 37% to 27% between 1984 and 1997 (Anonymous, 2000). According to research conducted by Arthur Anderson, young men are five times more likely than young women to select computer science or computer related majors in schools (Cohen, 2001). Also, women are not entering university computing and information technology courses at the same rate as men. If this situation persists, the gender imbalance in the computer technology industry could worsen. Women are, therefore, excluded from the exciting prospects promised by information technology.

There are issues of stereotyping and false perceptions permeating throughout society that women are less competent in technology compared to their male counterparts. These misconceptions could be one of the reasons for the low enrolment rate for women. Previous research suggests that girls receive little encouragement to explore computers early in their schooling (Henwood, 2000). Some suggest that there are few female role models in technical industries (Cockcroft & Cunningham, 1995). These problems may each contribute to part of the overall problem of declining female participation. Identifying reasons leading to the problem helps us to understand the gender imbalance. Surveys have been conducted to see if the genders and domains of the case studies influence student participation in IT (Wong & Paynter, 2001). However, no consensus could be drawn from the results. Seeking ways to increase women's participation remains an important but yet unsolved task.

Gender imbalance is not a new topic in the information systems (IS) research realm. Much effort has been spent in identifying remedies to combat the problem. Evidence shows that women of Asian ethnicity significantly outnumber other ethnic female students, both in Australian and New Zealand IT degree studies (Cockcroft & Cunningham, 1995; von Hellens & Nielsen, 2001). European studies, too, show an ethnicity bias with female participation decreasing in Western European countries but not in developing nations, including Eastern Europe (Schinzel, 1999, 2002). It seems that cultural differences may be more influential than gender alone. This finding forms the background of this research. Social and cultural factors have to be considered together with inherent gender differences. The gender imbalance issue in the IT industry is a social as well as cultural construct that can be improved if its causes are being identified and therefore appropriate measures are being applied.

Cognitive Style and Learning

Kirton's Adaptor Innovation (KAI) Inventory is a 33-item questionnaire. It is a pre-tested and validated instrument. It consists of 33 questions in the form that looks like the Likert scale often used in Information System (and other) surveys. Kirton claims KAI measures creativity in his adaptation-innovation theory, which was first introduced in 1976. The adaption innovation theory studies individuals' cognitive styles. The theory classifies people's cognitive styles as lying on a continuum with adaptive and innovative on two opposite poles. The associated tool for the theory is called Kirton's Adaption Innovation (KAI) Inventory. KAI measures people's cognition and it is especially effective for identifying a person's learning preferences as well as problem solving styles. Creators have a high KAI, while Adaptors have a low one. Kirton's study states that each person has a preferred problem-solving style that remains stable over a lifetime.

Individuals develop coping mechanisms to deal with circumstances which are at odds with their preferred problem-solving style, but as soon as the situation allows, return to the preferred style; positive or negative outcomes are not necessarily the result of differences between adaptors' and innovators' problem-solving approaches but of situational factors. (Kirton, 1976 as cited in Osborne, 1995).

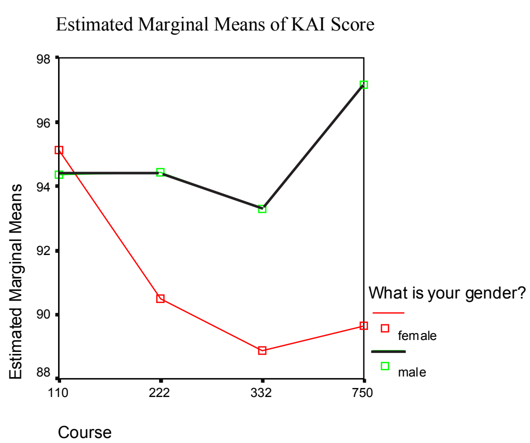
To assist practitioners, Kirton encourages a distinction between level (what is done) and style (how it is done). It is said that level may be affected by intelligence, knowledge and experience while style develops early in life and persists over time, regardless of age (Osborne, 1995).

Methodology and Findings

This research started by examining the ethnicity and gender composition of the students taking information systems courses at the University of Auckland Information Systems Business School. It then used a survey instrument (KAI) to examine different cognitive styles to see if this had an influence on their participation. Students were initially surveyed during their lectures and follow up surveys were sent to those who were not present on the day the surveys were initially given.

The students taking the courses surveyed represent a mixture of genders and nationalities and ethnicities and have a variety of educational backgrounds. The first year information systems course is typically a mixture of IS and non-IS majors, whereas the second and third year classes have a more technical orientation (e.g., computer science, engineering, information systems). For female students it was found that year I students had the highest KAI, while the mean KAI of stage III students was the lowest. The stage II mean KAI score was higher than those of stage III and lower than those of stage I so that there was no statistical significance between stage II and the other two groups. This finding was interesting and it led us to ask what type of female students the university is retaining. As Kirton (1978) suggested that people's problem solving styles are consistent over time, it is unlikely that female students become more "adaptive" as they proceed to higher levels. In other words, it is likely that the Information Systems major is attracting and retaining females of "adaptive" problem solving styles. Enrolment patterns show that different genders have different preferences in selecting their major. Learning styles are deter-

Figure 1. Impact of course and gender on KAI



mined by cognitive styles, and different genders have different learning styles. Gender has an effect on influencing individuals' cognitive styles. This is perhaps the most important finding of the work to date. It implies that innovative females may not be attracted to Information Systems courses beyond the first year (Figure 1).

FUTURE TRENDS

The observations made about IT participation in the Australasian universities are not unique. In Europe (Schinzel, 2002) it appears that it is the children of recent immigrants who gravitate to the IT field. Indeed, 50% of those of European ethnicity taking the IS program at the University of Auckland were recent immigrants.

The low participation of Pakeha (European ethnicity) women in IT courses and then in the work force does nothing to overcome the fears of those who feel that Asians dominate the courses and the industry. Affirmative action is needed to promote the place of the Pakeha females in IT courses and the industry to overcome the stereotypes that seem to be developing (Cockcroft & Cunningham, 1995; Wong & Paynter, 2001). At this stage it is not clear what action can be taken in the courses themselves. One possibility is to reintroduce case studies that themselves can promote participation across cultures and gender. Female students may feel more at home in the social atmosphere of discussing cases (a role typical of analysts) rather than in lab-based exercises behind a computer (Wong & Paynter, 2001). Another approach is to use role models but there is little evidence to suggest that this works and most accounts are anecdotal (von Hellens & Nielsen, 2001).

The less than expected growth in electronic commerce has seen a downturn in the IT industry. IT appears less attractive to potential students. In Auckland we have become heavily dependent upon the foreign student market. This is exacerbated by the low participation by the New Zealand born students. It is clear that we must restructure and reposition our current courses. This is a challenge for educators world-wide.

Most of the Asian students return to their homeland after completing their degrees. Even those who came to New Zealand earlier in their lives for secondary schooling and obtained Citizenship or Permanent Residence (PR) often do not find satisfactory employment in New Zealand. We have started interviewing those who have entered the IT workforce in New Zealand (Chan, 2004) and Hong Kong (due to its accessibility) in order to reconcile their educational and industry aspirations.

CONCLUSION

This is an exploratory study that aims to understand the factors influencing the ethnic and gender imbalances in IT participation. Judgment sampling was employed to distribute the KAI survey. Future research should employ a probability sampling to ensure that the findings can be generalised. One approach would be to survey final year courses in other disciplines where the gender and ethnicity patterns differ. We will also continue to interview IT workers and students in Hong Kong and New Zealand, as well as conduct focus groups in New Zealand to look at the issues arising from this study.

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KEY TERMS

Adaptor: Someone who is more suited to following instructions, doing things by rote. It is considered that much of IT is learned and done this way (e.g., modifying programs, writing documentation, doing database queries in SQL). In fact, with the emphasis on templates and reuse this will become even more the norm.

Gender Imbalance: It is perceived that the IT industry and enrolment in IT courses are dominated by males. This is exacerbated by the lifestyle (nerdish long hours behind a computer screen), role models, and even the gender of text book writers.

Innovator: Someone who prefers starting things from new. Hence, there is room for creative flair. Kirton (1995) proposes that everyone falls into a creativity continuum ranging from doing things better (adaptors) to doing things differently (innovators).

Kirton's Adaptor Innovation (KAI): Kirton's Adaptor Innovation (KAI) Inventory is a 33-item questionnaire. It is a pre-tested and validated instrument. It consists of 33 questions in the form that looks like the Likert scale often used in information system (and other) surveys (Kirton, 1987).

Pakeha: "White" people, those of European descent compared to the native people (Maori) or more recent Polynesian immigrants.

Indigenous Women in Scandinavia and a Potential Role for ICT

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INTRODUCTION

From a distance, the Sámi Network Connectivity initiative (SNC) does not necessarily appear as anything but another technical research project with certain science-fiction (sci-fi) connotations. It is aimed to create Internet connectivity for communications-challenged terrestrial settings using a protocol currently being developed for communications in space. However, while being a highly technical project, SNC emerged from an unexpected setting: an Indigenous women's initiative to save their traditional livelihood from threats of social and economic drain and to create better opportunities for women and youth to remain within the traditional community.

The first step towards the formation of SNC was taken in June 2001 when a group of women reindeer herders in Sirges Sámi Village in Jokkmokk, Norrbotten County in northern Sweden decided to start a gender equality project, Kvinna i sameby (KIS).[1] To the Sámi, reindeer herding serves not only as an economic base but also as a foundation for reproduction of cultural values. Already in the KIS planning stage, Susanne Spik, the project leader, contacted the Division for Gender and Technology at Luleå University of Technology (LTU) to invite scientific assistance from the early stage of the project. LTU is the regional technical university for northern Sweden and is situated in the Norrbotten County capital of Luleå 200 km southeast of Jokkmokk. Promoting women's possibilities to remain in reindeer herding and the traditional Sámi community, especially social and technical conditions for work and business development, were the focus in the discussions. An associated but separately funded project was subsequently formed by LTU researcher Maria Udén. A solution to the project requirements came from a guest researcher at the computer science department, Avri Doria, an Internet systems architect. In spring 2002, after initial discussions with members of the Interplanetary Networking Research Group (IPNRG) at the NASA Jet Propulsion Lab, she contributed the proposal that came to be referred to as Sámi Network Connectivity. With a decision to accept this project, the establishment of SNC as both a technical idea and a concrete gender-based project became a prime goal for the cooperation between the women in Sirges and the scholars at LTU, and continued after the KIS project ended in December 2003. The SNC objective is to provide connectivity where other sources are not available, while making the local population part of the development of the technical system. To develop the technical solution space of SNC, the Sámi Network Connectivity proposition gained research funding from the Swedish national agency for innovation systems, Vinnova, for the period 2004 to 2006. This funding is distributed through the Vinnova program "New communication networks."

BACKGROUND

Being a technical project, it is not obvious how SNC relates to the understandings of the sex/gender and gender equality concepts, as these are maintained in women's movements and feminist theory. SNC is a result of a women's movement among the Sámi and will be shown also linked to the current feminist movement in academia. More than a unified position of gender issues, the common motivating factor shared by all participants in the SNC is a shared appreciation of grass-roots participation in technology development. To feminist researchers in science and engineering, formulating critiques of their mother disciplines is not a sufficient goal. The vision and expectation is to be able to present theoretical and methodological alternatives (Keller, 1992; Mörtberg, 2003; Trojer, 2002).

This has strongly affected the research scope of gender studies at LTU, where the presence of engineers, mathematicians, and systems and computer scientists has been substantial from the start. The SNC project is one among other activities aimed at changing the relations between gender and technology initiated in this environment. Internationally, the LTU research scope is consistent with aims and considerations expressed by, among others, Evelyn Fox Keller. It is characteristic, however, that feminist researchers engaged in science and technology continue to acknowledge difficulties in taking the step from observation and critique to presenting functional alternatives to/within them. Keller (1992) put the question of feminist interventions in science and their possible success as follows:

In short, feminist theory has helped us to re-vision science as a discourse, but not as an agent of change. And it is this latter question that I want to press on now. Since it is demonstrably possible to envision different kinds of representations, we need now to ask what different possibilities of change might be entailed by these different kinds of representations? (p. 76)

Though more than a decade has passed since Keller expressed these concerns, feminist methods for effectively acting as agents of change in science and technology are still barely developing, even in the field of Information and Communication Technologies (ICT), which have indeed generated a large body of feminist studies during the late 20th and early 21st centuries. Reasons behind this lack of progress are thought to be located in various social, cultural and economic factors, all of which are affected by symbolic, as well as material connotations, of sex/gender (Bratteteig, 2002; Mörtberg, 2003; Trojer, 2002). In this respect, the significance of the networks between engineers/scientists and the individuals and organizations that request and make use of their products and results, the patrons, must not be overlooked. These networks tend to be male dominated not only on the experts' side but also on the patrons' (Cockburn, 1985; Keller, 1992; Trojer, 2002; Udén, 2002).

CHALLENGES AND POTENTIALS

Sámi Lifestyle Today, its Challenges to ICT and the SNC Solution Space

Even if Sweden is indeed one of the world's most "Internet-connected" nations, the districts of concern to the reindeer herders are not as well off in this respect. The level of service and ICT access is significantly lower than in Swedish society at large. In 2002, The Swedish National Rural Development Agency investigated the infrastructure available in the Swedish Sámi herding communities, especially the summer lands. Among other reasons, the summer lands were chosen for the investigation as they are especially valuable for keeping the children's link with Sámi culture, and for both cultural and social reproduction in other respects. It showed that the majority of residents' camps in the summer lands have very little or no access to infrastructure, including post delivery, telephone and roads (Glesbygdsverket, 2002). Given that Sirges and its neighbor, Sámi Villages, to a large extent, operate in a large, 9,400 km^2 connected area of natural preserves and other protected areas, it is understood that installment of fixed infrastructure, such as major masts for mobile communications, are not wanted. This area of wilderness is known as Laponia, and listed by UNESCO as World Heritage. To the reindeer herding Sámi in Sirges and surrounding villages, Laponia is not wilderness, but their cultural landscape.

Today, the Sámi are an indigenous minority population incorporated within the Scandinavian and Russian national states, and their traditional lifestyle is challenged by conflicting demands. Many of these conflicts stem from the fact that maintaining economic and social sustainability makes it necessary to be part of modern society, which puts demands on being, more or less, resident in a fixed location, while their traditional lifestyles—in particular, reindeer herding—continues to require a more nature-based lifestyle and semi-nomadicity. (Haetta, 1993;

Jernsletten & Klokov, 2002) One basic assumption held within SNC is that access to the Internet could, to a certain degree, enable resolution of these conflicts. In fact, a venue for innovation is opened as the notion arises, that ICT is not genuinely available on the premises of Sámi semi nomadism, as this notion challenges popular understandings of ICT as eliminating boundaries in time and space, making place and time irrelevant, being limitless.[2] Yet, this potential is not only a myth but materially inherent in ICT, something that all of us who check our e-mail from hotels we stay at for a day or two as readily as from our homes or offices can benefit from. Perhaps this potential is even more valuable to a nomadic population than to others. If participating in local politics (which is vital to a minority population), making use of the new options for distance education, consulting healthcare services, generally keeping up business contacts and specifically running e-based business concepts would be possible from the grazing areas and in points of time adjusted to herding requirements, much of the strain on the individuals and on the community could be avoided. As herding is based on organic time and constant moving with the herds and the seasons, while the majority of society is based on the mechanical clock and steady settlement, the buffer capacity of ICTs and their innate capability of changing the implications of time and place carry the potential of making semi nomadism a more feasible lifestyle tomorrow than it is today.

The connectivity mix in the regions where the Sirges herders operate is constrained both by availability and possibility. While there is a mix of data delivery opportunities—for example, wired, wireless and digital television, in particular throughout the rims of the herding region—there are vast areas where none of these delivery mechanisms are available. Furthermore, the fact that much of the terrain is protected means that neither antennas nor cabling can be installed. The SNC solution to this challenge does not offer real-time services. Instead, providing robust connectivity is prioritized. The idea is that mobile relays periodically travel human byways to locations where gateways to the Internet are available, carrying data bundles that can be exchanged. Thus, connectivity is coupled to *presence*, relying on the movement and encounters of the population rather than being based on an even availability over a huge and periodically unused area. Current reports of the solution space include Lindgren and Belding-Royer (2005), Lindgren and Doria (2005) and Lindgren, Doria, and Schlen (2004). Doria, Udén, and Pandey (2002) gives an overview of both technical and social impetus of SNC.

Women in the Sámi Villages and the Potential Role of ICT

When we present the SNC project, in almost every audience someone will ask why an indigenous people, and especially its women, should want high-tech, ICT development. To understand the implications for the semi-nomadic reindeer herders of Scandinavia, it is necessary to first acknowledge that there are aspects of a needs-and-demands analysis that would turn out the same having any activity built on field work in focus; for example, tour guiding and wildlife monitoring. For these, any computerized or Web-based system must be available in the field to genuinely be of use. Additionally, there are aspects of access to ICT that are specific for the Sámi reindeer herders as indigenous people. These aspects tend to turn out differently between women and men.

We have already mentioned that the reindeer herding communities are subjects of stress caused by conflicting demands from modern society and their traditional lifestyle. A critical Sámi women's movement has reported how women are often those who have to take on major parts of this mediating labor, and how the very limited resources available to women to fulfill the expectations put them in a situation of strain. Reindeer herding has also become increasingly a masculine matter, in part as a result of this split of life of traditional life and modern society and lack of coherence between the culture and economic base on the one side, and modern structural organization and demands on the other. This masculinization is not acceptable from a gender equality point of view, as women suffer both socially and economically from it, and it also threatens the vitality of the culture (Kråik 2002).

The vision of SNC is to be an active and positive part in bringing the potentials of ICT into use in a contemporary re-establishment of traditionally based nomadism. One example of possible use of ICT to resolve the conflict between traditional and modern is the compulsory school system that, though it is valuable insofar that it provides necessary and valuable education to all citizens, still has the specific disadvantage to the reindeer herding communities in that it hinders children of the reindeer herding families from being present in the grazing lands as much as is needed to gain traditional knowledge. As a consequence of the need for children to stay near the school in town, mothers' possibilities to migrate with the herds are limited as well (e.g., Ulvevadet & Klokov, 2004.). If Internet-based distance education were available, this conflict, the gendered effects of which are based in traditional division of labor among the Sámi, could be reduced. Thus, Sámi women, while enhancing a traditional identity, could gain from high-tech development.

This, however, is not an expectation free of reservations. Development of ICT for use in the grazing areas could also lead to the opposite extreme; increased strain and further marginalization of women in the Sámi Villages. It is reasonable to assume that the chance for gender-sensitive results of deployment of new means for communication rests upon the way in which women and men take part in development and employment. In this respect, the SNC process contradicts expectations on gender roles in the Sámi community as well as in Swedish innovation systems in general.

Difficulties that women and minorities may experience in taking part in ICT development were among the issues particularly addressed by The Working Group on Internet Governance (WGIG, 2005, pp. 2-3):

One weakness of present systems is that people who are excluded today may be in that situation partly because their involvement is structurally hindered in more or less all "normal" partnerships for development within their country. This can often be the case for minorities and women. These groups will have additional problems when compared to other local groups, in developing Internet use and in benefiting from the ICT potentials to improve their quality of life. ... Even if other paths may be open, e.g. access to technical expertise, generating the resources needed for implementing change can be dependent on relations with the same authorities that in other instances do not acknowledge the disadvantaged group as legitimate partners.

FUTURE TRENDS

Apparently, being a high-tech project, SNC emerged from an unexpected setting: an alliance between high-tech professionals, gender studies scholars and a locally situated indigenous people's gender equality project. New and unexpected actors and alliances stepping forward are not unknown in ICT development. Rather, such events have been intrinsic and altogether part of the process. The early development of the Internet, including the steps that made it available to other than elite scholars and military, grew from a mix of well-established and unexpected actors (Castells, 1996). Nevertheless, the significance of gender, ethnic identity and location has not been less in ICT sectors than elsewhere. At this point, it is too early to establish that SNC is typical for a coming stage of technical and organizational innovations, where yet more unexpected things happen and gender barriers and ethnic patterns are challenged. What we can note is that SNC to a certain degree has been successful, even a remarkably successful endeavour. Yet, at the start we envisioned technology transfer, with pilot development and deployment in cooperation with the requesting community. As it turned out, it has been more difficult to find resources for these activities than for the university-based research. We did not expect this, as there are European Union structural funds and various national and regional funds allocated for the development of the remote northern regions of Sweden.

CONCLUSION

The SNC process represents a notable novelty in terms of technology development. Significant factors are the active role of women as patrons; these women's rural location, ethnic identity and explicit gender equality agenda; and the operational part played by feminist scholars. The novelty of the process opens a rich array of research opportunities, including but not confined to representations and change in science, and the advance of alternative feminist paths for science and engineering. Not least, working in and from an alliance between women technicians and women patrons exposes pre-conceptions, skills and knowledge gaps of our own as well as of other actors. Certainly, we also note how structures may or may not support an endeavour such as ours. But the resources available to the SNC group have this far been allocated to the system development itself and to building strategic alliances to reach our aims of user participation and technology transfer.

In consequence, the positive research results achieved to this point primarily belong to the technical solution space. From the standpoint of feminist and gender theory, we note how concepts of gender and technology, and specifically understandings of their relations, may be exposed and challenged in an action-oriented endeavor such as SNC. Also in the case of SNC, concepts of ethnicity, location and tradition are at play.

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KEY TERMS

Innovation System: A network of organizations, people and rules within which innovative exploitation of technology and other knowledge take place.

Interplanetary Networking Research Group: A former working group within the Internet Research Task Force that developed the bundling architecture for Delay Tolerant Networking.

Information Technology (IT) or Information and Communications Technology (ICT): The technology required for information processing. "In particular, ... the use of electronic computers and computer software to convert, store, protect, process, transmit and retrieve information" (Wikipedia, 2006).

Sámi: The indigenous people of Scandinavia. According to official estimations, there are 70,000 to 80,000 Sámi.

Sámi Village: Grazing community whose members are entitled to let their reindeer graze within its area.

Working Group on Internet Governance (WGIG): Established by the United Nations Secretary-General in order to present a report "for consideration and appropriate action for the second phase of the World Summit on the Information Society WSIS in Tunis 2005" (World Summit on the Information Society [WSIS], 2006).

ENDNOTES

1 English: Woman in the Sámi Village.

2 This popular understanding has been frequently referred to in marketing, for instance, in promoting laptops as enabling working from "any" location—for example, from home—and also referred to in public policy documents. For instance, the Swedish Government's Proposition 1999/2000:86, "An information society for all" stated that: "IT represents a new base technology comparable to e.g. electricity. It is characterised by speed and interaction, and it is *limitless*" (our italics).

The Influences and Responses of Women in IT Education

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INTRODUCTION

This article highlights findings from an empirical study that explores the nature of female underrepresentation in information technology. Specifically, this research focuses on (a) identifying key sociocultural factors that can facilitate the pursuit of IT at the undergraduate level, and (b) testing Trauth's (2002) Individual Differences Theory of Gender and IT through a comparison of female responses to the social construction of IT. To answer the author's research questions, interviews were conducted with 10 female seniors in an IT department at an American university in the mid-Atlantic region (MAU).[1]

Although experiences with social factors vary, comparing the stories of women who have successfully navigated their way into and through an IT undergraduate degree program reveals common influences and motivations. In addition, though some common factors may facilitate female entry into the field, the Individual Differences Theory of Gender and IT explains that women will react differently to the social constructions of gender and IT. By gaining a better understanding of the gender imbalance, applying appropriate theories to explain the problem, and uncovering the challenges that women of our society face in their entry to the field of IT, collegiate programs can more effectively implement strategies that will improve the recruitment and retention of female students.

BACKGROUND

IT-related undergraduate degree programs such as computer science (CS), management information systems (MIS), and information-science and -technology programs are important gateways to the IT industry, providing valuable exposure and experience to students interested in pursuing IT careers. Research suggests that women are entering undergraduate IT programs in smaller numbers (e.g., Camp, 1997; Freeman & Aspray, 1999) and may be doing so with less formal and informal IT experience (e.g., Craig & Stein, 2000; Fisher, Margolis, & Miller, 1997; Margolis & Fisher, 2002; Teague, 1997). Thus, education at the undergraduate level is critical in the foundation of their skills, their interests in IT, and their pursuit of work in the field. Moreover, actively recruiting and retaining females in IT-related undergraduate degree programs can have a significant impact on the diversification of the IT workforce. As Margolis and Fisher (2002, p. 3) explain, "women must be part of the design teams who are reshaping the world, if the reshaped world is to fit women as well as men."

This study first focuses on identifying sociocultural factors influential in women's decisions to pursue IT at the undergraduate level. The social-construction perspective of gender and IT explains that, reflective of the social norm in America, cultural expectations and influences often convey the message that women are unsuitable for the IT world (e.g., Trauth, 2002; von Hellens, Nielsen, & Trauth, 2001). By the time young women reach college, there is evidence of the effects of these social norms and expectations. For example, in the years prior to college, certain studies have revealed that, in comparison with males, females exhibit lower levels of self-efficacy in computing, are less likely to explore computing independently through informal channels (e.g., within peer groups, computer camps, and clubs), and elect to take advanced computing courses less frequently; in addition, some women have misconceptions about the IT workforce and IT work (e.g., Beise & Myers, 2000; Craig & Stein, 2000; Fisher et al., 1997; Margolis & Fisher, 1997, 2002; Nielsen, von Hellens, & Wong, 2000; Symonds, 2000; Teague, 1997; von Hellens, Nielsen, Doyle, & Greenhill, 1999; Woodfield, 2000).

An examination of the factors that enable women to confront and circumvent these social barriers is an important part of understanding the gender imbalance; however, it should not be assumed that all women have the same reactions to these barriers. The Individual Differences Theory of Gender and IT embraces the notion that gender is a fluid continuum rather than a dichotomy. This theory focuses on women as individuals, having distinct personalities, experiencing a range of sociocultural influences, and therefore exhibiting a range of responses to the construction of the IT field (Trauth, 2002). Comparing and contrasting females' responses to the social construction of IT tests the individual-difference theory of gender and IT.

RESEARCH APPROACH

This research focuses on women at a critical point of IT entry: the undergraduate level of education. In examining the trends of female underrepresentation discussed in the literature and the theoretical perspectives used to explain the problem, the following research questions emerged.

1. What significant sociocultural factors in the lives of women are influential in their pursuit of IT at the college level?
2. How similar are female responses to the social construction of gender and IT?

To investigate these questions, in-depth interviews were conducted with a sample of 10 female seniors in MAU's IT department in the spring of 2003. The IT department at this university was chosen because of its proactive stance with respect to the recruitment and retention of women students. The department also has a diversity committee and a student organization, Women in Information Technology (WIT), that was established to provide support and mentoring for female students in the program. At the time of these interviews, the student enrollment in the department was 21% female. Interviews were open ended and lasted approximately 40 minutes in duration. The qualitative format was selected as it was most appropriate for capturing in detail the participants' broad range of influences and experiences. Interview questions were derived from the themes of family background, educational history, personal traits and interests, discovery and selection of the IT program at MAU, experiences in the program, and future plans.

FINDINGS

Comparing Sociocultural Influences

In comparing participant experiences, the women study reported modest levels of formal education and informal experimentation in IT; these experiences made little impact on their decisions to pursue the IT degree. Participants consistently described their education in high-school computer classes as basic. The two women who elected to exceed the minimum computing requirements and complete C^{++} classes felt they lacked a clear understanding of the extent to which the language could be applied in real-world scenarios. On the whole, these high-school computer classes served the purpose of familiarizing these women with computers, but did little more. Although a few of the participants were aware of certain IT careers, the majority did not have a clear and complete understanding of the IT field prior to college. In terms of computing exposure and use in the home, experiences were quite consistent and corresponded strongly with the literature (e.g., Margolis & Fisher, 2002). The primary functions of home computers were education and communication: word processing for homework, and e-mail and instant messaging for chatting with friends.

Family influence and encouragement was a key social factor identified as impacting the participants' decisions to pursue the IT program at MAU. Despite differences in family environments, common to each of the women's experiences was a high level of parental academic support, encouragement, and expectation. The participants had mothers, fathers, and siblings that were, to varying degrees, actively involved in their academic careers. Many of the participants were pushed for academic achievement, and many were also specifically encouraged to choose the IT program at MAU. Other participants reported less direct academic involvement, though expectations and encouragement remained strong. This encouragement, with little exception, helped the women create high personal expectations for their future careers.

In developing an understanding of gender roles, the participants grew up in homes where mothers and fathers assumed diverse roles and responsibilities. Regardless of their family environments (e.g., dual income, sole breadwinner, single parent), the children in these households, male and female, were treated equally. The participants were raised believing they were able to achieve whatever they wished, and that gender was not a factor that should steer them in one direction or deter them from another. This confidence facilitated their selection of MAU's IT program. This confidence was also revealed in the way the women dealt with male domination in the IT department; half of the participants reported being largely unaware of the gender imbalance, and the remaining half, though initially intimidated by the experience gap, learned quickly that they were equally capable of achieving success in the program.

The presence of role models was another significant factor that influenced participants' decisions to pursue IT. Lacking a significant amount of formal and informal experience in IT, the women's IT understanding was strongly correlated with the presence of a role model. Consistent with the literature (e.g., Beise & Myers, 2000; Craig & Stein, 2000; Symonds, 2000; Teague, 1997), IT role models affected how the women perceived and related to the field, exposed them to opportunities in the field, and helped them develop an interest in IT work. The majority of females with IT role models entered college with a general understanding of the field they wanted to pursue.

Specific characteristics of MAU's IT program were also influential in the participants' decisions to pursue IT. In particular, the program was perceived by the women as new, exciting, cutting-edge, and as offering a wide range of both technical and nontechnical business-related educational opportunities. A number of the participants also described positive experiences with IT program advisors. Finally, the fact that the IT program was formed with close ties to industry and emphasized postgraduation employment opportunities was a principal factor in the participants' decisions.

Exploring Individual Responses

Findings regarding personal future expectations and outlooks provide clear support for the Individual Differences Theory of Gender and IT. Individual differences were most clearly revealed through the participants' outlooks on female participation in IT and expectations for their own futures.

Although the participants arrived at the same source of IT education, differences in their interests, values, and priorities will cause some women to maintain their participation in the IT industry, and others to reevaluate and change careers. Half of the women in this study strongly believed IT was the field they wanted to pursue, did not envision themselves switching careers, and were committed to balancing their work and family lives. The remaining half of the participants expressed uncertainty over whether or not they would remain in the IT field. Some of these women were unsure they would enjoy the IT industry and indicated a desire to explore other fields, while others anticipated an incompatibility in balancing an IT career with expectations for family commitments in the long term.

Differences in formative experiences have also led these women to hold a variety of opinions about female participation in IT: differences in their explanations of the gender imbalance, and differences in their opinions on how and whether or not the issue should be addressed. In offering explanations for the underrepresentation of females in IT, opinions were split between those who believed women were simply less interested in the technical subject matter, and those who believed the imbalance persists due to a lack of female exposure to the field. Additionally, some of the women felt that the gender imbalance in IT was a significant issue and that, in certain situations, intervention was necessary to provide support for females. However, the perspective most frequently described by this group of participants was the belief that hypersensitivity about gender issues can be problematic and can place unnecessary emphasis on the division between the sexes.

CONCLUSION

The analysis of females in the IT program at MAU reveals high levels of encouragement from family, exposure to IT through role models, and balanced perceptions of gender roles and expectations to be the primary social factors facilitating participant decisions to pursue this IT-related undergraduate degree program. Specific characteristics of MAU's IT program were also influential in attracting the participants to the department. In particular, the program was perceived by the women as a cutting-edge program with a comprehensive curriculum, and as capable of providing access to great career opportunities. Finally, in investigating participant outlooks on female participation in IT and expectations for their own futures, this research found strong support for the Individual Differences Theory of Gender and IT.

The participants' stories also revealed that their high schools were an untapped source of potential influence, exposure, and encouragement. Findings suggest that improved IT education in high school could provide females with exposure to the field they might not receive elsewhere, which would greatly support the development of interest in IT. Findings also indicate that high-school IT courses should be developed with an emphasis on both technical knowledge and real-world business applications of the subject matter. Additionally, women should be actively encouraged to participate in these courses and explore computing beyond minimum requirements. Finally, high school would be an appropriate place to provide young women with exposure to female role models in the industry, a factor that is particularly important when role models are not present within the home.

Finally, in discussing the women's expectations for the future, implications for female retention in the IT industry emerged. As exemplified by this participant group, there are both unpredictable success stories and unexpected stumbling blocks. One participant, for example, entered MAU with great uncertainty and little career orientation. Having been strongly encouraged by her father to achieve academically and pursue the IT program, she secured a summer internship where she discovered a specific technical focus within IT she enjoyed and became intent on pursuing. In contrast, another woman described growing up as a tomboy and was the only participant to exemplify the "boy-wonder syndrome"[2] (e.g., Margolis & Fisher, 1997). Her conditions for IT selection were very favorable: a strong interest in technology, exposure to IT, strong role models, encouragement, and confidence. Yet, she felt her participation in the industry was temporary because of her desire to pursue other interests she viewed as more compatible with the kind of family environment she wants to create. To increase female participation in IT, we should first strive to make conditions for the selection of IT education most favorable so that with exposure and experience in the field, women may find their niche among the many lines of work that IT has to offer. Retention strategies at the undergraduate and industry levels are the next step; however, they are beyond the scope of this research.

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KEY TERMS

Boy-Wonder Theory: The belief that true scientific talent, interest, and achievement must be exhibited early in one's lifetime.

Individual Differences Theory of Gender and IT: The perspective of gender and IT that argues that "women as individuals experience a range of different socio-cultural influences which shape their inclinations to participate in the IT profession in a variety of individual ways" (Trauth, 2002, p. 103).

Social-Construction Perspective of Gender and IT: The perspective of gender and IT that attributes female underrepresentation to societies' incompatible constructions of femininity and the IT field.

Tomboy: A female considered boyish or masculine in behavior or manner.

ENDNOTE

1 The name of this university has been changed.

2 As Sheila Tobias explains, "one of the characteristics of the ideology of science is that ... both scientific talent and interest come early in life—'the boy wonder syndrome'. If you don't ask for a chemistry set and master it by the time you're five, you won't be a good scientist" (Margolis & Fisher, 1997).

Institutional Characteristics and Gender Choice in IT

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INTRODUCTION

While the issue of attracting women to information technology professions has been studied extensively since the 1970s, the gender gap in IT continues to be a significant social and economic problem (Thom, 2001). Numerous research studies have been conducted to understand the reasons for the gender gap in IT (Gurer & Camp, 2002; Sheard, Lowe, Nicholson, & Ceddia, 2003; von Hellens, Nielsen, & Beekhuyzen, 2004). Universities and colleges have developed a variety of programmatic efforts to apply gender gap research results, implementing strategies that increase female undergraduate enrollment in computer science programs (Wardle & Burton, 2002). Yet, individual successes have not translated into any significant change in the overall percentages of women choosing IT. An analysis of current choices of women in their selection of four-year undergraduate institutions reveals yet another alarming trend—young women are not choosing to study IT at the traditional academic four year institutions that would best prepare them for the IT professional careers of the future.

To complicate matters, the information technology job market is changing rapidly. For example, some well-documented IT trends that are causing such shifts are outsourcing, the commoditization of IT, the effect of the dot com bust on the job market, and most importantly, the integration of IT into the fundamental economic, social and cultural fabric of our society. IT now permeates every aspect of professional work, even the traditional female-oriented occupations such as nursing and teaching. This integration of IT into the professions must guide the development of a new set of strategies to insure that women have equal opportunities and access to the benefits of an education that prepares them for professional careers. It is in the best interest of the IT profession and our society in general to help young women make choices that include the pursuit of information technology.

BACKGROUND

The under representation of women in IT is a critical issue of equity and access for women due to the pervasiveness of computing in our society, the many economic opportunities afforded those who have technology skills and knowledge, and value of diversity for this profession (Cohoon, 2003). Although job opportunities in technology companies and technology-oriented industries have recently declined, the need for advanced technology skills in mainstream business careers and entrepreneurship remains critical (Thibodeau & Lemon, 2004). Nearly 75% of future jobs will require the use of technology, 8 of the 10 fastest growing occupations between 2000 and 2010 will be computer-related. The annual mean salary for computer and technology occupations remains significantly above average compared to all occupations (U.S. Department of Labor, 2004). Thus, the IT gender gap translates into salary and employment inequities.

Table 1 shows that in 1996, women were 41% of the IT workforce compared to 34.9% in 2002, yet they accounted for 46% and 46.6% of the overall workforce in 1996 and 2002, respectively. Note that, in 1996 and 2002, the higher percentage of females was due largely to greater numbers of women in Data Entry and Computer Operator positions, jobs that required less formal education and experience, and provide lower pay. In fact, in both years, women

Table 1. Women in the IT workforce vs. overall workforce (1996 and 2002)

2002 Total	2002	2002		1996	
Employed (thousands)	Total	% Men	% Women	% Men	% Women
Electrical and electronic engineers	677	89.7	10.3	92	8
Computer systems analysts and scientists	1,742	72.2	27.8	72	28
Operation and systems researchers and analysts	238	51.3	48.7	57	43
Computer programmers	605	74.4	25.6	69	31
Computer operators	301	53.2	46.8	40	60
Data entry keyers	595	18.3	81.8	15	85
Total IT occupations	4,158	65.1	34.9	59	41
All Occupations	136,485	53.4	46.6	54	46

Source: Bureau of Labor Statistics

Table 2. Computer/information science bachelor's degrees awarded

Year		Degrees awarded			
		Total	Men	Women	% Women
1986		42,195	27,069	15,126	35.8
1987		39,927	26,038	13,889	34.8
1988		34,896	23,543	11,353	32.5
1989		30,963	21,418	9,545	30.8
1990		27,695	19,321	8,374	30.2
1991		25,410	17,896	7,514	29.6
1992		24,958	17,748	7,210	28.9
1993		24,580	17,629	6,951	28.3
1994		24,553	17,533	7,020	28.6
1995		24,769	17,706	7,063	28.5
1996		24,545	17,773	6,772	27.6
1997		25,393	18,490	6,903	27.2
1998		27,674	20,235	7,439	26.9
2000		37,388	26,914	10,474	28.0
NOTE:		Data not available for 1999			

account for over 81% of the data entry positions. The current lack of women in the IT workforce is in part a consequence of women not choosing IT undergraduate degree programs or dropping out of these majors.

One traditional path into the IT profession is the completion of an undergraduate degree in Information Technology. However, the percentage of undergraduate degrees awarded to women in computer science and information technology as reported by the National Center for Education Statistics has declined since 1986 (See Table 2). It is well known that one approach to moving women into IT is through the educational pipeline, that is, motivating young women to explore these career paths early in life and to choose IT degree programs.

Despite the benefits of professional technology careers and the advancements of women in many other fields, little progress has been made in moving women through the educational pipeline in computer science (Camp, 1997). In fact, less than 33% of participants in computer courses and related activities in high schools are girls (AAUW, 2000).

The extensive literature on this topic (Beyer, Rynes, & Haller, 2004, Gurer & Camp, 2002; Klawe & Leveson, 1995) provides us with many reasons why IT is not attractive to young women. Potential causes include: unsupportive academic environment, the perception of computing as a male-oriented profession, gender differences in how students assess their own performance, lack of role models and insufficient critical mass of female students and faculty to build community.

Colleges and universities face additional challenges in recruiting women. Because of the pipeline issue, women are often less experienced in computing when they enter college, computer science department cultures and software are typically male-oriented and don't appeal to women, and there is a lack of visibility regarding the social value of computing that would appeal to women. Furthermore, while some institutions have been successful in recruiting females to undergraduate computer science programs (Fisher & Margolis, 2002; Roberts, Kassianidou, & Irani, 2002), the percentage of women in these disciplines for most institutions continues to decline (ITAA, 2002). Cohoon (2001) argues that, based on her investigation of the University of Virginia's CS department, the characteristics and practices of computer science departments affect female retention at the undergraduate level and inherent female characteristics are an insufficient explanation of women's under representation in computer science. In fact, women themselves tell us why they are not choosing IT, often indicating they find IT uninteresting or perceive that it is more difficult academically than other professions such as surgery and law (Weinberger, 2004). Individual characteristics and environmental influences are explored to provide a perspective on women in IT in Trauth (2002) in order to better understand women's lack of involvement in IT.

Numerous recommendations to assist educational institutions in attracting women to undergraduate degree programs in IT appear in the extensive body of research on gender and IT (Baum, 1990; Cohoon, 2003; Cuny & Aspry, 2000; Wardle & Burton, 2002). Colleges and universities and academic departments that have been successful in increasing the number of women in technology have shared their strategies for recruiting and retaining female undergraduate students (Margolis & Fisher, 2002). They encourage institutions to establish and fund university programs and policies to expand the recruitment pool, provide a supportive climate with appropriate student services, broaden (not weaken) admission requirements, offer bridge programs, educate parents and teachers on gender issues, expand undergraduate research opportunities, and build supportive communities of learning through role models and mentoring.

Nevertheless, these successes are not widespread and the question of why women are not choosing computing as a major is a question that may benefit from institutional research. Exploring the characteristics of institutions that have been successful in attracting women may help us to better understand the choices that women are making when they do choose to pursue an undergraduate degree in IT.

USING DATA MINING TO DISCOVER WOMEN'S EDUCATIONAL CHOICES

Data mining refers to a set of techniques used to search large amounts of data for patterns. Rather than specifying a hypothesis, selecting a sample, and performing a test of the hypothesis, data mining instead searches the data for patterns that occur within it. Thus, it is a set of data driven techniques. The knowledge contained within the data set gives shape to the model. Three of the most used data mining techniques are cluster analysis, association analysis, and decision trees. In this analysis, we only used descriptive analysis as a first step in analyzing our data. Descriptive analysis was used to search a large data set for patterns and associations related to educational choices of women.

When a young woman leaves high school for college, she is making a career decision that influences the path she takes for the rest of her life. Not only the choice of major, but also the choice of the institution can have long-lasting effects on the possibilities available thereafter. The following preliminary research study compares institutions where women, in large numbers and in very small numbers, have chosen to concentrate in IT-related majors.

This study uses IPEDS (Institutional Post-Secondary Educational Statistics) data for 2000-2001. The purpose of this project is to discover factors associated with the type of institutions that have demonstrated success in attracting women to IT programs, using data mining techniques. The comprehensive IPEDS data set contains variables related to characteristics of the institution, including enrollment numbers by academic discipline using a variable called the CIPCODE (Classification of Instructional Program Code) reported by institutions of higher education. CIP codes indicating specializations in information systems, computer science and information technology were used in this study. The number of female students across these IS/IT CIP codes was calculated to give a total for each institution. This sum was divided by the total number of students at the institution, then multiplied by 100, to generate our target variable: Percent of women in IT/IS at the institution. This yielded a total of 985 institutions for our analysis. Institutions that had missing values on the variables considered, including both Not Reported and Not Applicable, were deleted.

The variables from the IPEDS data that we examined for this study, based on previous studies, included the following sixteen variables: accreditation of the institution, requirement of secondary school GPA for applicants, requirement of test scores for applicants, affiliation of institution, athletic association of the institution, provision of a meal plan, type of calendar system, highest degree offered, whether institution has a hospital, degree of urbanization, region code, on-campus housing, sector of the institution, availability of on-campus jobs, placement services, and variation of tuition. Four-

Table 3. Characteristics of the top and bottom institutions with respect to female representation in IT programs

Group		Bottom	Top
% Women in IT		< .0599	> .7817
Total in Group		119	121
Avg # Students		7947	4134
Category		**% in Category**	
Affiliation	Private, for profit	0.0	30.6
	Private, NFP, not relig.	21.0	31.4
	Private, NFP, religious	29.4	24.0
	Public	49.6	14.0
Highest Degree	Bachelors	11.8	33.1
	Masters	49.6	37.2
	Doctorate	38.7	29.8
Accredited	No	11.8	22.3
	Yes	88.2	77.7
Placement	No	3.4	22.3
	Yes	96.6	77.7
Dorms	No	2.5	33.9
	Yes	97.5	66.1
GPA Required	Neither	5.9	25.6
	Recommend	18.5	14.9
	Required	75.6	59.5
Test Required	Neither	0.0	10.7
	Recommend	2.5	17.4
	Required	97.5	71.9
Ath. Assoc. Member	No	3.4	35.5
	Yes	96.6	64.5

year institutions that offered an undergraduate degree in information technology in 2000-01 composed the data set to be analyzed.

All institutions were sorted by the value of the target variable. The group with the greatest percentage of women majoring in IT/IS areas is hereafter called the top group. The bottom group includes institutions with the smallest number of women majoring in IT/IS areas. In the top group of schools, the proportion of females is 0.78% or higher and there are 121 schools in this category. The bottom group is the set of schools with the lowest female representation, that is, under .06% and it contains 119 colleges and universities. Though the sizes of these two groups are about the same, they have very different sets of values on the IPEDS category variables as shown in Table 3. In our analysis, either we will only focus on those which provided new insights or great contrast between the two groups.

What are the characteristics of institutions that have the greatest percentage of women IT majors in their overall undergraduate population? The variables which show the greatest differences between the groups are: size, affiliation, highest degree offered, accreditation, placement services offered, dorms, athletic association, and entrance requirements. From the data, we observe that 22.3% of the top group are non-accredited while only 11.8% of the bottom group are non-accredited. Of the schools with the lowest female representation, 49.6% are public institutions, 0% are for profit, 21% are private, non-profit, nonreligious and 29.4% are private, non-profit, religious institutions. For those with the most females in IT, these numbers are 30.6% public, 31.4% for profit, 24% private, nonprofit, nonreligious and 14% private, nonprofit, religious. Thus, for the group with the best female representation, they break out into fewer publics (14% vs. 49.6%) and more private nonreligious institutions (31.4% vs. 21%). For the bottom group, 97% of the schools belong to an athletic association, but for the top group, this drops to 64.5%. We also note that 97.5% of the bottom group offer dormitories, while only 66% of the top group are schools are residential. The data also shows that 22.3% of the schools with high representation of women do not offer placement services as compared to 3.4% for schools with lower numbers of females in IT. Finally, 33% of the schools that have higher concentrations of women in IT offer nothing higher than a bachelors' degree, while 88.2% in the group not chosen by women offer masters' and doctoral programs.

Looking at this data in total, we see that the top group institutions tend to be smaller in size, private, and do not offer doctoral degrees. They are less likely to have any athletic association, to require an admissions test or secondary school GPA, or to provide dormitories.

FUTURE TRENDS

As many of the previous studies examining the gender gap indicate, this is a complex problem and one that requires a comprehensive, yet focused, institutional, and departmental strategy in order to bring about significant change. One critical component that will impact the agenda to increase IT enrollments is the changing face of the IT profession over the next decade. The traditional approaches employed must be supplemented with new strategies, addressing future IT trends such as outsourcing, the commoditization of IT, the effect of the dot com bust on the job market, the integration of IT into the fundamental economic, social and cultural fabric of our society, and the cycles of interest in academic areas of the current and future generations of undergraduate students.

There are multiple challenges—understanding why girls and women make the educational choices they do, attempting to change the culture to help them make choices that will prepare them for technology careers, and predict how the IT profession will change in the short run and the long run. In the short run, we see that the global economy and new impetus on IT to deliver business value are changing jobs from those that require traditional programming and software development skills to jobs such as project management and application integration that require teamwork and organizational skills (Thibodeau, 2004). In the long run, we need to design new ways to educate girls and women on the opportunities of using IT in many non-IT professions and engage them in interesting, challenging and meaningful work requiring technology skills. For example, areas such as nursing, teaching, marketing, and human resource management that have a large female professional staff are becoming increasingly IT-oriented. Specific examples are medical informatics in healthcare, customer relationship management in marketing, and meeting the needs of K-12 tech-savvy students.

Table 4. Recommendations for attracting female students to undergraduate IT programs

- Offer pre-college experiences such as summer technology camps
- Educate local high school counselors and teachers about women and IT careers
- Align 4 year programs with community college programs
- Provide "gap" educational programs to prepare students coming from institutions with different academic standards
- Develop baccalaureate programs that provide the skills needed for today's IT workforce
- Offer an array of ways to major in technology– CS, MIS, IS
- Hire faculty and staff who can provide insights into the variety of IT-related careers

CONCLUSION

Based on the research presented here, there are several conclusions and consequent recommendations for reducing the gender gap in IT. First and foremost, we need to educate girls and young women while they are in elementary and high school to help them make better choices regarding their future and lives beyond college. The pipeline begins at a very young age. Stereotypes and barriers are established early in life. If they are getting their degrees at unaccredited, non-PhD granting schools, we will not see them at research universities in the future, adding to further decline in the pipeline. Specific recommendations are shown in Table 4, incorporating what we have learned about the gender issue.

First and foremost, we must provide interventions early in girls' lives through programs that reach them and their teachers, parents, and counselors. If young girls are choosing to attend nontraditional and two-year programs, then we must connect with them at the community college level and align ourselves with these institutions. Aggressive recruiting and then providing "gap education", i.e., classes, workshops or seminars to bridge the gap between their educational background and those of the students who follow a more traditional path is the next recommendation. Finally, the ultimate challenge will come for all IT students as we better align our undergraduate curricula with the skills and knowledge needed to succeed in the next generation of computing.

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KEY TERMS

Accredited Institution: Institution that is accredited by national institutional or specialized accrediting agency that establishes operating standards for educational or professional institutions and programs, determine the extent to which the standards are met, and publicly announce their findings.

Computer Science: Study of data, computation, and information processing, including methodologies, processes, hardware, software, and applications.

Data Mining: Search of large databases for patterns and trends using a variety of techniques implemented by computer software, sometimes referred to as KDD.

Gender Roles: Professional or social roles associated with males or females that are socially acceptable and considered to be the norm.

Gender Studies: Theoretical and empirical work that focuses on gender in society.

Information Technology: The technology associated with information processing, including computer hardware and software used to store, process and transmit data and information.

IPEDS: The Integrated Postsecondary Education Data System (IPEDS), established as the core postsecondary education data collection program for the National Center for Education Statistics, is a system of system of surveys designed to collect data from all primary providers of postsecondary education.

KDD: Knowledge discovery and data mining; finding applicable insights through the analysis of large amounts of data.

Pipeline: Channel that moves an object from start to finish; used metaphorically to represent the number of qualified individuals who move from one stage in the educational process to another.

Private, For-Profit Institution: A private institution in which the agency in control receives compensation other than wages, rent, or other expenses for the assumption of risk.

Private, Nonprofit Institution: A private institution in which the agency in control receives no compensation other than wages, rent, or other expenses for the assumption of risk. These include both independent and those affiliated with religious organizations.

Public Institution: An educational institution whose programs and activities are operated by publicly elected or appointed officials and supported primarily by public funds.

The Intersection of Gender, Information Technology, and Art

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INTRODUCTION

The interdisciplinary field of art and technology is now well established in artistic and academic communities (Wilson, 2001). However, this article will focus on how the combination of technology and art can be used to facilitate the expression of thoughts, the experience of ideas and the explorations of concepts dealing with gender. A research project called the Art of Decision, which focuses on women in decision making, is used as a means of investigating the ways in which creative technologies can illuminate aspects of gender studies.

BACKROUND

Creative Technologies

In the context of the research presented here, information technology (IT) is defined very broadly as an entire array of mechanical and electronic devices that aid in the storage, retrieval, communication and management of information. It includes all computing technologies and mobile and fixed communication technologies, but it is not restricted to those areas. Smart materials that change attributes on the basis of input stimuli and that can be used to present and display information or react to information, holographic systems, sensors, audio technologies, image technologies, video technologies and many more are all of interest. In this article, the term "creative technology" is used to describe the combination of these types of technologies with artistic practices and methods or the use of these technologies in an artistic manner or in a mode that follows a particular artistic aesthetic. The use of technology for artistic expression is widespread, and while very many works of art can be of a political nature, the concept of using art and technology in the construction of purpose-build systems for exploring gender questions is novel.

Gender

Gender is a complex category of analysis that defies simple definition. It can be viewed as the result of socialization—the emphasis of 1970s/1980s second-wave feminist theorists (Nicholson, 1997) or more currently of performance, of the repetition of doing gender, "the repeated inculcation of a norm" (Salih, 1993, p. 139). This article endorses the view of gender as a result of the interaction between biology and the social environment—what Anne Fausto Sterling calls the "complex web" (Sterling, 2000). It endorses her repudiation of the sex-gender or nature-nurture divide that she claims fails to "appreciate the degree to which culture is a partner in producing body systems …" (Sterling, 2005, p. 1516). This entry also reflects the view of Caroline Ramazanoglu, who takes "gender to include: sexuality and reproduction; sexual difference, embodiment, the social constitution of male, female, ... masculinity and femininity" (Ramazanoglu, 2002, p. 5). Finally, it appreciates the views of Alsop, Fitzsimons and Lennon, who hold a multifaceted view of gender that includes gender as a "feature of subjectivity," as "cultural understandings and representations of what it is like to be a man or a woman" and "as a social variable structuring the pathways of those so classified within society" (Alsop et al., 2002, p. 3). What must be emphasized in all these definitions is that gender intersects and interacts with other factors of identity, such as class, race or sexual orientation.

A definition of gender must include a theory of power. Gender is not a neutral concept, but rather, different degrees and kinds of power attach itself to genders in specific ways. Again, it is important to understand the power of gender as it intersects with all the other human differences. For example, in its simplest form, the traditional white male middle-class gender speaks of political power.

Power, however, is important in other ways. It is integral to the joining of creative technologies and gender, and in this context is defined as the power to produce, authorize and impart knowledge. Often, traditional science and technology have assumed the air of impartiality and objectivity, which gave them the veneer of having produced "authoritative knowledge." Joining gender to art and technology is to problematize questions of objectivity, authority and knowledge production.

Using new creative media in an exploration of gender and power opens up new possibilities for studying that relationship. This is of particular importance in an age that often considers it trendy to speak of postfeminism, of the "idea that feminism has had its day" (Davis, 2004, p. 140). It is in this context that this article argues that the joining of gender and art and technology through the use of feminist methodology can invigorate a discussion about gender and allow for the presentation of material on gender in new and exciting ways.

THE INTERSECTION OF GENDER, IT, AND ART

The use of creative technologies with its flexibility, crossing of boundaries, multidisciplinarity and interdisciplinarity lend themselves to feminist inquiry and provide a space to develop feminist research. At the most basic level, the tools available to us allow material on gender to be presented in a new and exciting way. While this, of course, applies to material of any nature, the use of these techniques in the gender sphere is particularly appropriate.

Gender studies are underpinned by feminist research methodologies. Feminist methodology is interdisciplinary and multidisciplinary, drawing insights from different fields and weaving them together through an understanding of feminist theory. For example, Ramazanoglu's definition of feminist methodology (Ramazanoglu, 2002) speaks about feminist methodology as being grounded in women's experience and seeks to analyze connections among ideas, experience and material reality. DeVault, on the other hand, discusses the need for "excavation ... that is to find what had been ignored, censored and suppressed, and to reveal both diversity of actual women's lives and the ideological mechanisms that have made so many of those lives invisible" (DeVault, 1999, p. 30). Reiharz includes in her definition an emphasis on multiplicity of methods and perspectives, of being transdisciplinary, of the effort to create social change, of being inclusive (Reiharz, 1992). Jenkins et al. see "the concept of power as central to feminist research" as well as noting the importance of "how the researcher and the researched have been gendered, sexualized, raced and classed" (Jenkins et al., 2003 p. 2, 4).

Irrespective of the exact definition used, feminist methodologies incorporate the desire to give women an opportunity to tell their stories, express their views and have their voices heard. In essence, it is women-centered. It acknowledges that researcher and researched are "gendered, sexualized, raced and classed," and both bring these characteristics into the research project (Jenkins, 2002). We consider the interaction of gender with other characteristics of identity as vital to understanding the complexities of research. To summarize very broadly, feminist research methodology: (1) places major emphasis on valuing a variety of viewpoints, (2) is highly concerned with remaining true to the voices of both those who research and are researched, (3) embraces complexity of argument, and (4) incorporates elements of social responsibility and a desire for social change. IT and, in particular in this case, the combination of the technology with artistic practices and methods, can play a major role in the first of these three essential criteria, as shown in Table 1.

As can be seen from that table, the negative potential of the technology is also listed. However, the existence of these very obvious negative factors also has a role to play. Often, traditional science and technology have assumed the air of impartiality and objectivity that gave them the veneer of having produced "authoritative knowledge." In the current

Table 1. Feminist methodology criteria and technology impacts

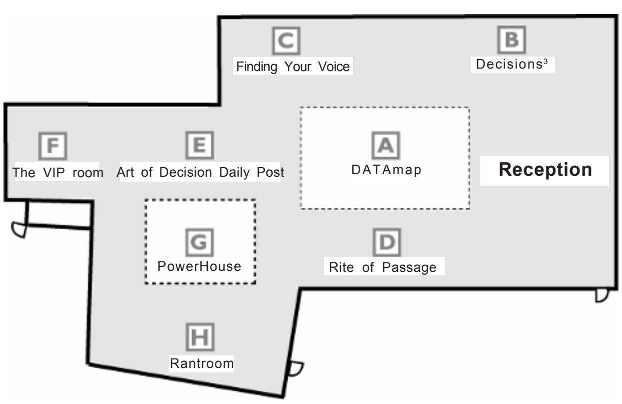
Feminist Methodology Criteria	Technologies of Interest	Positive	Negative
Capturing of Variety of Viewpoints	*Communication Technologies* Fixed networks, wireless networks (mobile communication systems, 2G, 3G, IEEE 802.11, Bluetooth, Zigbee, WiMax and so forth, ad hoc networks and so forth) *Communication Applications* Web, e-mail, sms, voice, instant messaging, blogs, moblogs and so forth *Communication Interfaces* Non-traditional input devices, Haptic interfaces and so forth	Wider access for broader ranges of people to participate in research, debate, conversation and so forth. More possibilities for viewpoints to be captured.	Digital divide that excludes large portions of the population from the online sphere.
Remaining True to the Voices	*Devices* for capturing voice, video and text and widely available *multimedia applications* for the manipulation and or creation of content.	Multimodel means of self-expression reducing the need for verbal or written expression only. Possibility for complete and unedited representation of the voice.	The ability to manipulate and distort and misrepresent data more easily than ever.
Embracing of Complexity	*Applications* that allow non-linear presentation of information (hypertext, etc.), applications for complex visualization of systems, immersive environments, virtual environments, gaming technologies and so forth.	The opportunity to deal with complex themes and topics in accessible and interesting ways.	Information overload.

world, this is very much not the case. Exploring gender with creative technologies opens the discussion on how knowledge is produced, authorized and imparted. It helps to problematize questions of objectivity, authority and knowledge production.

The Art of Decision

The ideas introduced in this article are illustrated through an example of a research project undertaken jointly by the Centre for Gender and Women's Studies and the Department of Electrical Engineering at Trinity College in Dublin, Ireland. This project, known as the Art of Decision, was funded by the Irish government through the Department of Justice, Equality and Law Reform and the European Union. The project aims to bring more women into political decision-making. To show how creative technologies and gender can combine in an effective way, a large interactive multimedia exhibition was specially designed and built. The exhibition took place in a Dublin city center warehouse during May 2005 and was open to the public. The exhibition comprised a series of rooms that immerse visitors in situations that invite them to reconstruct their perceptions of political structures and political involvement as women. Fionnuala Conway (artist and technologist) and Jane Williams (gender studies researcher), both from Trinity College, played a major role in the design of the Art of Decision. Figure 1 shows a schematic of the exhibition. Visitors enter the reception area and wander around the space as they please.

Figure 1. Art of Decision exhibition plan



DATAmap

This is a large-scale (47x20 meter) interactive map of Ireland designed to present statistical data on the gender balance on Irish State bodies in more than 70 locations around the country. Users walk on the map and sensors embedded in the map trigger the associated area information on surrounding screens. The DATAmap presents information in a visually interesting and memorable way, depicting the statistics on women and men as pairs of symbols from everyday life – knives and forks, matches and flames, while suggesting a gender for each object. The presentation of the information in his manner highlights the arbitrariness of gender categories and opens discussion on gender categories.

Decisions, Decisions, Decisions

This is a short documentary film where nine people present their perspectives on decision-making. The film is screened in three parts, all three parts running concurrently and in the same location. As the user approaches the three screens, a jumble of voices emerges and it is only by standing in the correct location that sense can be made of the film. In many ways, this project reflects the conflicting nature of decision-making, the "'messiness" of the process and the fact that neither men nor women have a monopoly on decision-making procedures.

Finding your Voice

These are simple audio pieces that present unedited stories of two activist women. The stories are presented in two small, intimate spaces as audio installations with lighting design that responds as the stories unfold. The actual voices of the women are heard and their stories are told in their own, unedited words.

Rite of Passage

Images of the visitors to the Rite of Passage are digitally captured and their faces are superimposed on a large digital mural of figures from political life in Ireland, using image signal processing techniques. The power that attaches itself to gender, in this case the masculine gender, is evidence from the dominance of white middle-class men. As women's faces are superimposed, the balance shifts and we are able to see a more gender-balanced picture.

The Art of Decision Daily Post

This is a giant interactive newspaper projected on a large wall of the room. A headline is automatically pulled at random from an online daily newspaper and displayed as the Art of Decision Daily Post headline and is based on technology by Doyle, Conway and Greene (Doyle et al., 2003). Visitors to the room can text their reactions from their mobile phones to the headline and the reactions appear as text of the newspaper. This is particularly relevant for gender concerns, as it can trigger a spontaneous discussion on current issues important to gender studies.

The VIP Room

The VIP room contains interactive pieces that allow visitors to explore power relations through the manipulation of graphical representations of people's understanding of power. Drawings from participants are converted to digital format and displayed on the walls of the room. The images can be rotated and explored through control with joysticks. This exhibition illuminates the way in which women see the flow of power and the ways in which the power attaches itself to gendered institutions.

PowerHouse

The PowerHouse is a photographic exhibition presented in a set-designed caricature of a home, its garden and street. Seventy anonymous participants were given disposable cameras and asked to take photos that represent their ideas of power and include comments on the photographs. The visitor is invited to find these photos and comments in the PowerHouse. The research participants' evaluations of how their attitudes to power changed over the course of the project are also presented over speakers in the PowerHouse. The images can be viewed as on online exhibition at www.imagesofpower.net, where viewers are encouraged to contribute their own comments on the photographs. Using photographs to capture ideas of power provides a different way to capture what power means. Having a camera for a period of time to capture the images creates a persistent alertness to the notion of power. The "voices" of women are heard through the images they chose to take. This type of approach allowed a wide range of women to participate without the need to be able to write skillfully or express themselves eloquently. It also meant that the unedited view of the participants, namely, their photographs, could be presented without interpretation by the researchers.

Rant Room

This is the last exhibit in the journey and is intended as a resting space. Visitors can relax here and text or mail their opinion and comment on the exhibition. The comments board is continuously updated in the space and online during the exhibition so that visitors have the opportunity to send their comment from any remote location via text and e-mail and see it on screen in the space. This exhibition simulates discussion on gender issues. It is an excellent mechanism for allowing voices to be heard in an uncensored manner and for collecting data on views about gender.

FUTURE TRENDS

The ability to stimulate thinking and discussion about gender can increase with the growth in creative technologies. This is particularly important among the younger segment of the population. What was quite striking in the Art of Decision project was the appeal it had to second-level students (students in the 12-18-year age group). They responded positively to the presentation of ideas about gender, gender imbalance and the arbitrariness of gender categories. Thus, joining creative technologies and gender in an interactive manner has the potential to revitalize interest in and discussion about gender among younger cohorts of men and women.

CONCLUSION

Using creative technologies to explore gender enables the researchers to design research projects that cross traditional boundaries and create spaces for women to participate in an active and engaged manner. Using the principles of feminist methodologies focuses the research projects on being women-centered and about doing research in the interests of women. They involve the researched in an active and engaged manner in the evolution of the project. Some allow the participants to change the direction of the research by their input. All stress agency. Moreover, these projects are about raising awareness and consciousness, about presenting information in a new and engaging manner. They tackle issues of power imbalance and work towards bringing new faces into a revitalized feminist debate. When feminist methodology is linked to creative technology, the results are powerful and our understanding of the operation of gender is magnified.

On a theoretical level, the joining of gender, feminist methodologies and creative technologies is most exciting. Creative technologies disrupt the traditional notions of authority and the authorization of knowledge. Because it is technology and technology is allied to science, there is an expectation of authority, validity and objectivity. But creative technology problematizes these expectations and instead focuses on issues of subjectivity, of nonlinear thinking, of multiplicities and imaginings. The questioning of traditional authority characteristic of feminist methodology is given added weight when allied to creative technologies. It reinforces one of the beliefs of feminist methodologies that the authorization of knowledge is not an objective process based on a detached analysis. Rather, it stresses the fact that knowledge and the authorization of knowledge is political and provides the mechanism to reveal that this authorization is raced, classed and sexed.

Moreover, linking creative technology to gender provides opportunities for many, especially those not necessarily comfortable with technology, to not only understand the technological dimension to their project, but to take ownership of it. It calls into question the divide that places technology as a "masculine" tool and allows men and women to participate in this field.

By harnessing the power and potential of creative technologies to feminist methodologies, a richer, stronger, more dynamic understanding of gender may emerge.

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KEY TERMS

2G, 3G: Second-generation and third-generation mobile phone networks (cellular networks).

Ad Hoc Network: A collection of nodes that form a network on an as-needed basis without the need for any preexisting infrastructure.

Blog: This is the short form of Weblog. A Weblog is a personal journal published on the Web. These journals typically contain informal thoughts of the author in the form of posts or short dated entries in reverse chronological order.

Bluetooth: A technology specification for small form-factor, low-cost, short-range radio links between mobile PCs, mobile phones and other portable devices.

Gender: Gender is primarily defined as the interplay between biology and culture in which definitions of femininities and masculinities are developed and dispersed in accordance with their norms. These definitions are neither unity nor static, so that one can speak of hegemonic masculinities or emphasized femininities.

IEEE 802.11: A wireless local area network standard.

Instant Messaging (IM): A text-based computer conference over the Internet between two or more people who must be online at the same time. When you send an IM, the receiver is instantly notified that he or she has a message.

Moblog: This is similar to a blog except in the case of a mobile Weblog (or moblog)—the content is posted to the Internet from a mobile or portable device, such as a cellular phone.

SMS: Short Message Service, or also known as text. SMS facilitates the sending of text messages on mobile phone systems.

WiMAX: A standard for delivering point-to-multipoint broadband wireless access. Specifically, WiMAX is an acronym that stands for Worldwide Interoperability for Microwave Access.

Zigbee: This is a proprietary set of high-level communication protocols designed to use small, low-power digital radios based on the IEEE 802.15.4 standard for wireless personal area networking.

Introducing Young Females to Information Technology

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INTRODUCTION

The difficulties in recruiting females into information technology and computer science (CS) have been well documented. Engineering disciplines have faced the same problem for many years. Some of the main underlying issues include unsupportive classroom environments (Hall & Sandler, 1982), gender-related perceptions of performance, a lack of role models, and inadequate peer communities (Zappert & Stansbury, 1984). Other contributing factors are the amount of positive computing experience gained prior to enrollment at the university level (Robers, Kassianidou, & Irani, 2002) and self-confidence. Research provides significant evidence to indicate that, even though females perform at the same levels as their male counterparts, they have less confidence in their abilities (Arnold, 1993; Fisher, Margolis, & Miller, 1997; Sax, 1994; Strenta, Elliot, Matier, Scott, & Adair, 1994). This lack of confidence keeps many females out of the technical classes. Finally, those females that do enter IT or CS courses may come to the discipline with multiple interests and, consequently, feel out of place at times among their more single-minded male counterparts (Widnell, 1988).

While it is predicted that 8 of the 10 fastest growing occupations from 2000 to 2010 will be in the IT or CS fields, it is expected that women will not be equally represented within these occupations (http://www.bls.gov/oco/ocos267.htm; Camp, 1997). The underrepresentation of women in computer science was given priority in the June 2002 special issue of *SIGCSE Bulletin* dedicated to women and computing, bringing focus to previous and current research regarding this dilemma. One particular factor highlighted in this bulletin is that changing this male-dominant field requires the crucial step of targeting young females in an effort to dispel stereotypical ideations and gender bias associated with computer science, thus attracting more women to the profession (American Association of University Women Educational Foundation, 1999).

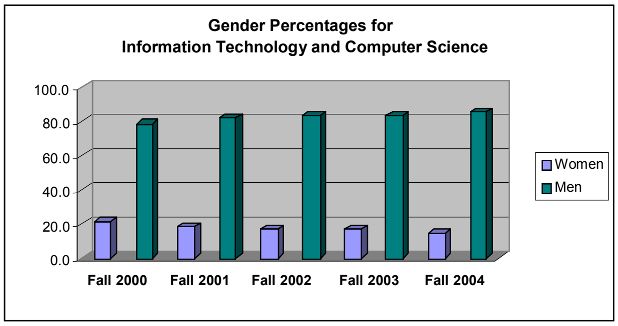
Girls in Science and Technology (GIST) is a free science and technology camp at East Tennessee State University (ETSU) making efforts to change these trends. The primary goal of the girls-only GIST camp is to introduce females to the fields of information technology, computer science, and math by providing discipline-related activities, enhancing teamwork competency, connecting females with women mentors working in the field, and creating a challenging yet fun atmosphere free from male competition. The hope is that this exposure will instill technical confidence and aptitude in the young females that will last through their college careers, giving them a positive outlook on information technology.

BACKGROUND

The enrollment statistics at ETSU for undergraduate degree-seeking students indicate that women are underrepresented within the IT and CS majors. In fact, these statistics show that women lost ground over the last 5 years. Note the downward trend in the percentages of females enrolled in IT- or CS-related majors at ETSU shown in Figure 1.

An analysis of data from the Office of Institutional Effectiveness and Planning at ETSU shows female enrollment at 21.4% vs. male enrollment at 78.6% in the fall of 2000. However, in 2004, female enrollment dropped by 6.3% compared to an in-

Figure 1.



crease of 6.7% in male enrollment (Baxley, 2004). The underrepresentation of women in IT and CS at ETSU parallels nationwide research suggesting that women are not equally represented in computer-related fields (Camp, 1997). It is our goal to provide exposure and opportunities to females, especially rural, underprivileged females in East Tennessee, and help reverse this trend.

The GIST camp offers a different perspective in introducing young females to IT. Previous research targeting females, primarily between the ages of 12 and 16, has shown the effectiveness of science and technology camps in providing a climate free of male competition and gender bias (Countryman, Feldman, Kekelis, & Spertus, 2004). Additionally, other research notes the importance of implementing science and technology programs within elementary schools so young females will not lose interest or feel less competent in IT and other predominately male areas when reaching middle and high school (Entwistle, 2002). Based upon research and prior experience, leaders of the GIST camp are now targeting females between the ages of 10 and 13 by providing a free science and information-technology camp for middle-school females.

MAIN THRUST OF THE ARTICLE

GIST Camp Activities

Participants in the GIST camp are divided according to age to accommodate the developmental stages of the different age groups. Each 5-day camp session is held Monday through Friday. Camp activities for each week are structured in similar fashion. Each day consists of computer lab time, team-building exercises, and a science experiment or science tour, with female professional speakers visiting several times per week. The order of activities varies slightly during the week to accommodate the schedules of speakers and departments hosting science tours. However, there is a deliberate alternation between time spent in front of the computer and time spent physically active. Figure 2 contains a schedule from a sample day in the camp. The camp activities lead to our desired outcome of participants gaining exposure to science and information technology in an atmosphere encouraging uninhibited exploration and experimentation related to these fields.

Evolution of the Camp

A pilot summer-camp program was initiated by two faculty members from the Department of Computer and Information Sciences at ETSU in 2000. The camp consisted of two week-long sessions and included a broad age range of females, from 9 to 16 years. Beginning in June of 2002, the camp was started on an annual basis, targeting females ages 10 to 15.

After the pilot camp was completed, the researchers formulated two important questions: (a) What is the appropriate age range for this kind of program, and (b) what are the appropriate kinds of activities for the selected age ranges? After holding the camp for 4 years, the researchers feel they have a working answer for both of these questions.

The researchers decided to approach the question of an ideal age range for a summer IT camp in multiple stages. The first stage would be to target the age group of 12 to 13 years. If this proved to be successful, the program would then be expanded incrementally to include younger and older females. As long as each new session was successful, then new groups would be added to expand the range of girls included in the program.

Figure 2.

Sample Daily Schedule	
Lab Time	9:00 a.m. – 9:50 a.m.
Team-Building Exercise	10:00 a.m. – 10:50 a.m.
Lab Time	11:00 a.m. – Noon
Lunch	Noon – 12:30 p.m.
Speaker	12:30 p.m. – 1:15 p.m.
Science Tour	1:30 p.m. – 2:15 p.m.

To determine age-appropriate computer activities, researchers decided to choose projects, tasks, and programs that would demonstrate the wide range of topics in IT while staying true to the discipline. The scope of these tasks and projects would evolve in a trial-and-error form after each day of the camp and from year to year.

In 2002, one week-long session was offered for ages 12 to 13. No formal data were collected from this year, but the camp hosted approximately 20 females. The researchers used this first year to refine group and lab activities. The campers were easily able to sit and complete specific project-oriented tasks in front of the computer and were not inhibited when participating in group events.

Due to the success of the 2002 camp, a new week-long session was added in 2003 for ages 10 to 11. Additionally, the size of the sessions was expanded from 20 campers per session to 30 campers per session, and the researchers began to collect formal data about the camp sessions. Recruitment efforts, which included sending information to school counselors and advertising in the local paper, provided sufficient exposure to fill both sessions. While the 12- to 13-year-old females worked well with limited supervision or help and were able to problem solve effectively, the 10- to 11-year-old females required more individual attention and were easily frustrated upon encountering problems difficult for them to solve, whether hardware or software related. The difference in the responses of the two groups was attributed to the amount of prior computer exposure and general age-related maturity.

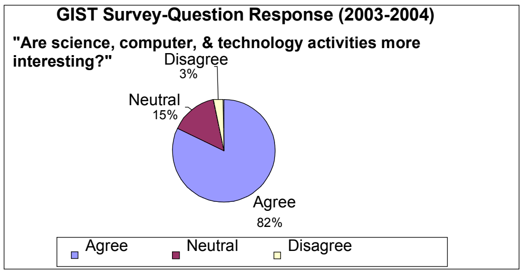
Based on experience from the 2003 camps, computer activities for the 10- to 11-year-old age group were altered to be more creative or game related, and simplified significantly for future camps. For example, an activity involving the development of a multipage Web site in Microsoft Front Page© was modified so that campers were developing a single Web page using Microsoft Word© instead. The goal for the youngest camp was modified from being project oriented to providing general exposure and fun with computers.

Based on the initial planned approach, the camp was expanded in 2004 to include 1 week for campers ages 14 to 15, and the number of campers per session was modified to 20 for the 10- to 11-year-olds and 25 for the 12- to 13-year-olds. Although the same recruitment tools were used as in previous years, recruitment for the 14- to 15-year-old session was noticeably more difficult. While there were waiting lists for the 2 weeks involving 10- to 13-year-olds, only 12 females signed up to attend the 14- to 15-year-old session. As an additional recruitment effort, personal visits were made to the schools targeting 14- to 15-year-olds. Researchers found during these visits to local school campuses that the 14- and 15-year-old females were very disinterested in the camp, and they heard many comments such as, "I hate math," or "Computers are boring." However, feedback showed that the females who attended the 14 to 15 session had a positive experience. In the comments section of the postcamp survey, one camper said, "I have really enjoyed this camp. I wish I could just keep coming to it year after year! It's been great," and another noted, "I hope this camp is offered next year. If it is you can expect to see me there!!!" In fact, 100% of the campers agreed or agreed strongly that they knew more about careers in computers, science, and technology and were more interested in these types of careers as a result of attending the camp (Laws, Loyd, & Price, 2004).

Following the outlined strategy for determining the appropriate age range for the camp, the researchers decided to eliminate the 14- to 15-year-old session for 2005 and concentrate on the younger ages. This decision was based mainly on the negative feedback experienced during recruiting activities. It seems that by ages 14 to 15, many females have already formed negative impressions of technology as a career or even as a fun hobby. Researchers decided to concentrate on the younger ages to help prevent the formation of these kinds of negative opinions.

The overwhelming positive response, excitement, and attendance of the 10- to 13-year-old females seem to indicate that reaching the females at the critical age range of 10 to 13 is ideal for this kind of camp. They are old enough to perform given technology tasks, but not so old that they have already formed negative opinions about computers and technology. Figure 3 shows that the overwhelming majority of campers aged 10 to 13 surveyed in 2003 and 2004 agreed or strongly agreed when asked if "science, computer and technology activities are more interesting to them because of the GIST camp" (Laws et al., 2004).

Figure 3.



The 2005 summer program consisted of three 5-day sessions with 20 to 25 females per session, serving at least 65 females within the age group of 10 to 13. Due to difficulty in maintaining age boundaries, enrollment criteria were changed from camper age to school grade. The three sessions were offered for rising fifth graders, rising sixth graders, and rising seventh graders. New activities with Lego Mindstorm© robots and Alice (http://www.alice.org) were introduced with much success.

Factors for Success

According to published research as well as data that we have gathered from the GIST camps, there are several factors that can affect female success in technical areas. These include exposure to role models, comfort level, confidence, and one-on-one instruction.

According to a survey of ninth- to twelfth-grade girls conducted by the Garnett Foundation, girls are less likely to pursue computer careers because there are not enough role models (Jepson & Peri, 2004). Therefore, the GIST camp sessions offer exposure to female role models working in the field of science and technology, and other material related to career options.

The case study by Shrock and Wilson (2001) showed comfort level as the number-one factor in contribution to success in an introductory programming course. The camp strives to provide a supportive atmosphere to discuss issues hindering females from reaching their potential in school or pursuing possible interests in science and technology. The all-female atmosphere is critical because it allows young females to be assertive in the education process and helps them gain confidence in their technical skills. Studies show that females are not normally assertive in technical arenas if males are present (Cuny & William, 2002).

Campers learn various IT skills during the camp, where they are challenged with age-appropriate activities. The session sizes are limited to a maximum of 25 campers, which allows for one-on-one interaction between the staff and the campers. This facilitates better material comprehension and a more positive experience for the campers. One-on-one tutoring is shown to be much more effective than classroom instruction and other computer-aided tutorials (Heffernan, 1988).

Measuring Success

A 16-question survey is used to measure the attitudes of GIST participants at the close of each camp session. Analyses of the survey results from camp participants help us determine whether we accomplish the following:

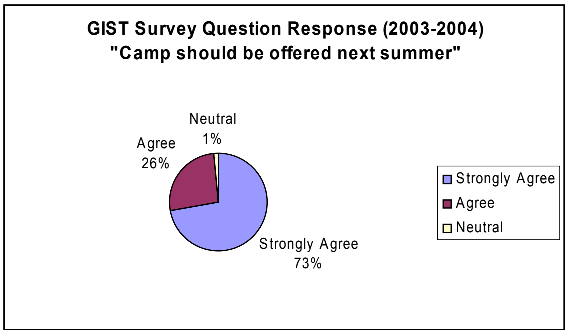
- Was the camp a success? Did the camp remove the “mystery” of computers, science, and technology; help the campers form bonds of friendship; and provide a fun yet challenging atmosphere for learning?
- Did the participants gain self-confidence regarding science and technology because of the camp?
- Was there a change in the participants’ perception of computers, science, and technology because of the camp?

Throughout the camp sessions, answers to all 16 questions were very positive. The question that sums up the overall attitude and success of the camp is, “Should this camp be offered again next year?” Figure 4 shows the results of this survey question for all sessions in 2003 and 2004. The feedback shows that the camps are very successful.

The participant survey as well as a survey for parents and guardians is completed online through a Web site dedicated to the camp. Completing the surveys in this format contributes to the goals of encouraging females to participate in and utilize current technology.

The dissemination of results of the camp is accomplished through press releases, brochures, a

Figure 4.



Web site, and a promotional video. These are used to provide outcome effectiveness to the surrounding community, thereby increasing future participation in the camp. Results of these camps are presented at conferences nationwide in the form of papers, panels, and tutorials to encourage professionals at other institutions to provide similar programs for young females in their areas.

The current Web site dedicated to the ETSU GIST camp is located at http://cscidbw.etsu.edu/gist.

FUTURE TRENDS

GIST is intended to be an annual event for at least the next 5 years. Participation in GIST should help the participants become part of a supportive, vertically integrated network consisting of themselves, female graduate and undergraduate ETSU students, ETSU mathematics and computer-science faculty, and distinguished female professionals external to ETSU.

By sharing information about GIST, we intend to reach beyond the East Tennessee area, creating partnerships with organizations and schools. We hope to eventually be able to collaborate with others to offer various activities that will continue to nourish young females throughout the year.

CONCLUSION

Learning from the success of other programs throughout the country, a plan was developed and implemented at ETSU to introduce young females to technical fields in an atmosphere full of fun and free of gender bias. The data collected during the camp are evidence that the participants gained an increased awareness of science and technology, offering a potential positive impact on their future.

As a result of this study, it has been determined that science and technology camps can be more effective when targeting females ages 10 to 13.

According to Cohoon (1999), there must be females already in the discipline in order to attract more females and retain them in the discipline. Therefore, collaborative research efforts among faculty, students, and professionals will persist each year as the summer camp continues in hopes of identifying a positive change in the recruitment and retention of females in science and technology at ETSU.

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KEY TERMS

Comfort Level: The level of feeling at ease, without inhibition, or the freedom to be oneself.

Dissemination: The process of distributing something, such as information. There are various methods of distribution that can be used including print, Web, and video.

Gender Bias: An unfair act or policy stemming from prejudice based on a person's gender.

GIST: Girls in Science and Technology.

Modified Likert Scale: A 5- or 7-grade rating scale with the *undecided* option removed. The scale measures the strength of agreement with a clear statement. It is often administered in the form of a questionnaire and used to gauge attitudes or reactions.

SIGCSE: ACM Special Interest Group on Computer Science Education.

Stereotypical Ideations: Forming ideas that conform to a presupposed type, idea, or convention.

Vertically Integrated Network: Relationships formed between people of various age groups and professional or educational classifications who share a common interest or goal.

Issues Raised by the Women in IT (WINIT) Project in England

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THE UK IT SECTOR: THE CONTEXT OF THE WINIT PROJECT

This article explores several issues raised by the European Social Fund (ESF) Women in IT (WINIT) project (February 2004 to February 2006) which focuses on women in the IT industry in England. The project consists of an online questionnaire aimed at women currently in the IT sector in England and those wishing to return to IT following a career or "carer" break (a break to care for children, or sick or elderly relatives). The WINIT team aims to target 750 respondents in order to collect and analyse data from a demographically diverse group on a range of issues including perceptions of fairness of pay, promotion prospects and future career aspirations. In addition the WINIT team are currently conducting a series of in-depth interviews with women in the IT industry in order to gain a rich understanding of these women's perceptions of, and experiences in, IT in England.

In order to explore the issues raised by the WINIT project it is important to consider the wider historical and contemporary socio-economic backdrop of individual women's experiences. The IT industry in Britain has experienced considerable expansion over the past twenty years. In November 2004 it was estimated that the IT workforce consisted of 1.2 million people (580,000 in the IT industry, with an additional 590,000 IT professionals in other sectors). There are also an estimated 20 million people in Britain using IT in their everyday work. All the above figures are predicted to grow between 1.5% to 2.2% per annum over the next decade (e-skills UK/Gartner, 2004). In terms of gender, in spring 2003 it was estimated that 151,000 women were working in IT occupations compared with 834,000 men, whilst in the childcare sector, there were less than 10,000 men working in these occupations, compared with 297,000 women (Miller, Neathey, Pollard, & Hill, 2004). To clarify, it is estimated that only 1 in 5 of the IT workforce in Britain is female (e-skills UK/Gartner, 2004). Such statistics indicate a classic case of *horizontal* occupational segregation. However, it must be noted that all statistics regarding the IT industry should be treated with caution given the problems of defining the sector (von Hellens, Nielsen, & Beekhuyzen, 2004).

In the UK, figures from the Office of National Statistics (ONS) indicate that women accounted for 30% of IT operations technicians, but a mere 15% of ICT Managers and only 11% of IT strategy and planning professionals (Miller, Neathey, Pollard, & Hill, 2004). Although women are making inroads into technical and senior professions there remains a "feminisation" of lower level jobs, with a female majority in operator and clerical roles and a female minority in technical and managerial roles (APC, 2004). Again this is a classic case of *vertical* gender segregation with women more strongly represented in lower level IT occupations than in higher status and higher paid ones (Miller, Neathey, Pollard, & Hill, 2004, p. 69). There is a relatively narrow gender pay-gap in the IT sector in comparison with all occupations. According to the ONS (2003), the gender pay-gap amongst ICT professionals in terms of hourly earnings stands at 7.5%, which is slightly narrower than the figure for all professional occupations.

WINIT'S THEORETICAL FRAMEWORK

The under-representation of women in the sector has been the focus of various initiatives in the UK over the last 30 years. These initiatives predominately draw on liberal feminist approaches to the women in computing "problem". Perhaps the most notable aspect of the 'liberalist' agenda is the recommendations for action advocated. The liberal feminist approach to the "problem" of women in computing, typified by Women in Science and Engineering (WISE) and Science, Engineering, and Technology (SET) discourses (Henwood, 1996) highlights the need to improve access to ICT, the need to encourage more women onto computing courses, and the need for better Equal Opportunities and Managing Diversity legislation. It is suggested that better gender equity will bring economic benefits for specific employers and for the UK economy, with the IT "skills gap" being narrowed through the greater participation of women in the IT industry (e-skills UK/Gartner, 2004).

There have been many criticisms of the liberal feminist approach in general terms and in terms of the actions advocated to address gender imbalances in IT settings (Cockburn, 1986). These include its tendency towards technological determinism, given that it leaves "technology" largely untroubled and views technology as "neutral" (Faulkner, 2000). The "individualism" of the liberal feminist approach to the "problem" of women and technology has also been highlighted as problematic, situating the "problem" as it does with the "failure" of women to realise the (liberating) potential of technologies (such as the Internet), their "failure" to properly engage with these technologies in home and workplace settings and their "lack" of awareness of the myriad of career options made available through technological engagement. We suggest, with others (Clegg & Trayhurn, 1999), that there is more to the women and computing "problem" than getting more women into the IT industry and into particular (high-paid, more prestigious) posts, although this is of course important.

With the contextualisation of the woman and computing "problem" comes the highlighting of the unsuitability of the IT workplace for many women; the long hours and presenteeism (Simpson, 1998) culture that exists within IT, negative perceptions of part-time workers in the IT sector (DTI, 2004) and of part-time work more generally (Epstein, Seron, Oglensky, & Saute, 1999), the instability of the IT market, and the deeply ingrained "masculine culture" of IT—these aspects need to change before (some) women can comfortably find a place within the IT industry. Rather than women, and for example older workers, being forced to "adapt" to the current IT culture, it is suggested that the IT industry needs to broaden its appeal to a more diverse pool of talent (Platman & Taylor, 2004; Women & Equality Unit, 2004). Having explored some of the work on gender and technology which has informed WINIT research, we now move on to some of our main findings at this initial stage.

THE WINIT SURVEY: INITIAL FINDINGS FROM 111 FEMALE ICT PROFESSIONALS

The WINIT team used contemporary literature, and expertise from academic and industry practitioners, to generate pertinent survey themes and questions. The online WINIT survey is securely hosted at the University of Salford. It went live in autumn 2004, and will remain so until autumn 2005. The WINIT team promoted the survey URL to a wide variety of women's forums, networking groups, special interest groups (i.e., BCS [British Computer Society] Women), IT recruitment agencies and female academics. This means that female ICT professionals who completed the survey self-elected to do so. Given that this is an online survey there was no predefined sample.

The majority of the initial 111 respondents were aged between 30-34 years of age (20%) while the second largest age group (16%) were aged between 25-29 years of age. This reflects the predominance of relatively young people within the industry (Platman & Taylor, 2004). In terms of living arrangements, 59% were living in a couple which incorporated being married, remarried, and co-habiting. Geographically initial respondents were predominately located in London and South-East England (40%), with North-West England (12%) having the second highest proportion of respondents, and Yorkshire a close third (11%). Fifty-nine percent of women in our initial cohort indicated that they had no children; while 40% had one or more. Seventy percent of respondents had no children living with them. Of the women who indicated that they had adapted their working practices as a result of having children, a shift to part-time work was the most common change. Behind such changes in working practices lie nuanced gendered experiences and gendered patterns of work and care. "Flexible" (but ultimately "feminised") part-time work remains of low-status within the IT industry (DTI, 2004). The low status of part-time work may curtail female part-timers IT career progression (Kodz, Harper, & Dench, 2002).

This said, 84% of women in our cohort had full-time or full-time flexi-time roles. This is significant given that 59% of the respondents had no children. Is this an indication of the possibility that for women in full-time IT positions raising a family is a difficult challenge to meet? A recent study (Gatrell, 2004) examining changes in family and working practices identified that highly qualified working women with children are suffering hidden discrimination from their employers despite current UK government work-life balance initiatives. Such "career vs. carer" difficulties were recognised by WINIT respondents, with one woman (Respondent No. 7) explaining, "It's all very well a company having a work-life policy or suggesting that they will try to support part-time/flexible working. What is needed is for them to actually act on this and prove they support it. I cannot see much evidence of this at present. I would hate to leave IT but in due course I hope to start a family and this will definitely take the highest priority". This respondent's concerns, about the un-family friendly policies and practices of many IT companies, are unfortunately supported by the aforementioned report (Gatrell, 2004), which found that organisations in many different sectors are still reluctant to employ working mothers. This problematic of combining home/caring and work responsibilities is exacerbated by the need for IT professionals to keep up with the rapid rate of change in the industry, making even relatively short career breaks risky.

Our initial cohort consists of women in a diverse selection of occupations in IT at a variety of different levels of seniority. A selection of our respondents included a Senior Software Engineer, a Senior Database Analyst, a Head of ICT, a Managing Director and a Professor of Software Engineering. These senior roles indicate that (some) women are progressing in their chosen profession. 59% of WINIT respondents believed that they have the same chance as promotion as their male colleagues, with only 36% disagreeing and 5% choosing "Do Not Know".

WOMEN'S PERCEPTIONS OF THEIR WORKING ENVIRONMENT

The WINIT survey includes questions exploring women's perceptions of their working environment including the support they received from their colleagues and line managers, the pay they received, how comfortable they felt talking about personal issues in the workplace and so on. Respondents were asked how they felt regarding the nature of their current IT employment in relatively general terms. Many respondents commented that they perceived their situation to be "fine", "very happy", "comfortable", "I love the work and the people", "convenient", "I love it" and "good conditions". However there was a contrary trend of disappointment and dissatisfaction; "I feel under-used and stingily metered out", "do not enjoy the post I currently occupy", "the extra level of hierarchy has restricted my growth in the company", "I would like to work part-time but that option is not available to me", "overburdening", "'potentially a great job but the workload is way beyond what should be expected", "overworked and underpaid". WINIT respondent No. 47, who had recently left the software industry to do a PhD, offered a snapshot of her former workplace saying, "Too many decisions and discussions took place down the pub. I have worked in IT over the last 20 years and still had to put up with people commenting on how unusual it was to see women writing software."

Our group of women are generally satisfied with their working environment. Sixty percent of WINIT respondents believed that their pay package reflects their workload, 61% believe that their pay packet reflects their current skill set, with 50% agreeing that their salary mirrors their highest qualification. Overall, 49% perceived that their individual position in the IT industry is reflected in their pay package, and 55% believe it is reflected in their position within their organisation. As a means to assess our respondents' perceptions of their salary, we asked whether there are any differentiating factors between their pay with that of male colleagues of a similar level. Sixty-two percent said it was comparable, and 77% said their female colleagues' salary was comparable, indicating a small discrepancy between (perceptions of) male and female pay amongst our respondents. We have thus far found few adverse trends in relation to female perceptions of their working environment. Seventy-two percent of our initial respondents believed that they are valued at work, while 77% of agreed that they are valued as part of a team. The data from this initial group of respondents conflicts somewhat with the "haemorrhaging" of women from the IT industry (IBM/George, 2003) but may reflect the fact that our respondents do, in the majority, work full-time and in the majority have no children. The Women in IT Forum has identified the retention of older and more experienced women as vital to the IT industry and suggests that flexible working initiatives would allow more of such women to remain in the sector (DTI, 2004).

A further theme was whether long-hour cultures and flexible working practices co-exist in the UK IT industry as reported in the DTI flexible working report? (DTI, 2004) There are comparable findings (with the above report) in the WINIT survey regarding a conflict between current long-hours culture and support for work-life practices. Sixty-seven percent of WINIT respondents state that there are flexible working initiatives in place within their organisation. This said, 64% report a long-hours culture. The IT Industry DTI report (2004) claims that 51% of IT professionals adopt a flexible working schedule but inconsistently 65% are working over 10 hours a day. Respondents felt that working flexibly would lower their pay, their status and diminish their promotional opportunities (DTI, 2004). This phenomenon is identified as the "take-up gap" by research conducted by the Institute of Employment Studies (Kodz, Harper, & Dench, 2002). Work-life balance initiatives such as part-time work, career breaks and job shares are in place in the IT industry, but heavy workloads and mangers' negative reactions formed barriers to the "take-up" of these options (Kodz, Harper, & Dench, 2002).

FUTURE ACTIONS, ASPIRATIONS, AND PERCEPTIONS

Thus far we have discussed initial WINIT findings in terms of the demographics of our initial respondents, their management of carer and career "clashes", the possibility of a long-hours culture in IT which may hinder attempts to adopt more "flexible" and/or "family-friendly" working practices, our respondents' perceptions of their working environment including promotion prospects and pay equity, and their overall satisfaction and/or dissatisfaction with their IT careers. But what of their *future* actions, aspirations and perceptions? (von Hellens, Nielsen, & Beekhuyzen, 2004).

In terms of personal career trajectories, responding to the statement "I can imagine myself working in the IT industry in the future", the majority of women (38%) said they strongly agreed, 17% moderately agreed, 12% slightly agreed and 17% agreed. This is in contrast to the 5% who slightly disagreed with the statement, the 5% who moderately disagreed, the 3% who strongly disagreed and the 3% who said "don't know". However these women's personal optimism did not match their overall pessimist view that the IT industry's image was unlikely to become more "female friendly" in the future. In response to the statement "The IT industry [will have] a female friendly image in the future", a mere 2% strongly agreed, 10% moderately agreed, 11% slightly agreed and 11% agreed.

Improving the IT industry's image to make it more "female-friendly", while admirable, may be somewhat problematic. To improve the image of the IT industry in England should not involve solely concentrating on *appearances* and negative perceptions. The image of the industry will only change if more is done to support women (currently) working in the industry who wish to combine home and family life. It is in this sense that we require initiatives which tackle the lack of affordable child-care facilities available in IT workplaces (and of course workplaces more generally), the lack of work-life balance initiatives (IBM/George, 2003) and the dearth of (desirable and respected) part-time IT positions, which may suit older workers and working parents in particular (Platman & Taylor 2004). It is in this sense that the under-representation of women in IT should not be configured solely as a "women's problem" but as problem of the industry itself and a problem related to the (unequal) gendering of domestic and care (i.e., parental) work. A socio-cultural contextualisation of the problem then shifts the focus from an essentialist notion of "woman" to the constraints of wider gendered society and gendered organisations in relational, interactional and institutional terms.

CONCLUSION

The women in the initial WINIT cohort are a heterogeneous group from a variety of educational backgrounds in a broad range of positions at all levels within the IT industry in England. Attention to this heterogeneity provides us with a nuanced view of women's experiences in the IT industry and offers a solid base on which to build further WINIT research. The under-representation of women in the IT industry as highlighted by the liberal feminist position clearly needs to be tackled. However, we have demonstrated in this paper that we also need to use other feminist approaches to gender and technology (Faulkner, 2000) in order to trouble these two inter-related terms. In so doing we can tackle the issue of under-representation without assuming that simply encouraging more women into the industry, say by improving its image, will be sufficient to tackle the continued complicated socio-cultural construction of IT as a "masculinised domain".

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KEY TERMS

Carer vs. Career: The difficulty some women experience in trying to manage domestic/caring responsibilities alongside their career. This difficulty should be viewed in the context of the continuation of the expectation that women are primarily responsible for the home and for children.

Flexible Working: Flexible working includes a variety of differing options with a reported aim of enabling people to better balance home life, family responsibilities, and working practices. Flexible working options are thought to include; part-time work, job-shares, flexi-time, time of in lieu, term time working, home, remote and teleworking, compressed hours and annualised hours.

Masculinised Domain: Suggests that within a given sphere of social life (i.e., the IT workplace) men tend to dominate proportionately (i.e., the under-representation of women in IT) and symbolically (i.e., that technology and masculinity are co-produced and that cultural images of technology are associated with hegemonic masculinity).

Presenteeism: The social/peer pressure to be seen to be at work beyond the call of duty and beyond contract stipulations, possibly to improve promotion prospects.

Take-Up Gap: The gap between the availability of flexible working practices (particularly part-time contracts) and the number of employees who opt for these ‘work-life balance’ initiatives.

Troubling “Technology”: From work in social and feminist studies of technology, challenging the assumptions that technology is “neutral” and suggesting that technologies are socially constructed.

IT for Emancipation of Women in India

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INTRODUCTION

At "One Village One Computer Campaign" (1V1C) in India we are resolved to tackle the gender question using information technology. The strategic slogan is "Age old problems, Youthful movement". Gender equality is sought in the context of the fight against a digital divide that is expressed through the problems of underdevelopment and exclusion. The approach is based on introduction of organizational innovations to raise human capital and social capital in the rural communities and connect them with each other and the world over through a knowledge network. In the hands of women, this becomes a weapon to fight against gender inequality and discrimination.

Through the use of information technology, a community centric approach can help rural India to combat social problems. In contemporary times where information, knowledge is the key to development and progress, IT can be used to combat the development concerns of rural India, while keeping local communities and their involvement and empowerment at the forefront of the process. As a technology IT is best suited for the "gendered" sex to empower themselves with education, information, knowledge, skills and so forth, and connect themselves with other rural communities and overcome physical isolation through IT network.

For resolution of gender problem, individualized IT empowerment has extremely marginal relevance, whereas tele-center like models based on private proprietorship has also very little success. IT Enabled Women's Social Network can be a solution in bridging the digital divide and gender problem. 1V1C campaign shows that it is possible to build such networks in remote villages and reach the most downtrodden and even illiterate women.

BACKGROUND

One Village One Computer started its work in village Mod, District Nandurbar of the state of Maharashtra in India, in the year 2000. A database of 3,000 landless laborers was created. The problems confronting destitute senior citizens, women, and patients were identified during the collection of this data and its processing. This led the laborers to organize agitation and make structured presentation of their specific health problems related to women, old people's pension entitlements, to the local health and development authorities. Thus, the problems were resolved immediately.

In the same year, this method was used in case of tribal women from Thane and Pune districts of the state of Maharashtra. Extensive data regarding ration cards for public distribution system (PDS), availability of food grains, functioning of ration shops under PDS, distribution of kerosene, black marketing of rations goods etc was collected. This concrete information could ensure that all deserving families obtained ration cards. This also helped in restoration of over 2500 ration cards, which had been arbitrarily cancelled by the authority.

1V1C project is in operation in 18 districts in the state of Maharashtra. Plans are drawn to ensure the spread of 1V1C in all the districts of the state of Maharashtra. 1V1C is collaborating with active people's organizations formed by peasants, landless labors, women, students, and youth.

1V1C is supported by the USA based organizations of people of Indian origin, such as Maharashtra Foundation and Asha for education. Ashoka Innovators for the public is supporting the project through the social entrepreneur fellowship program. People from IT, management, social research, media background from India and abroad contribute resources, knowledge inputs, and voluntary efforts.

A STRUGGLE FOR BRIDGING DIGITAL AND GENDER DIVIDES

An Overview of 1V1C

In this increasingly unequal world, one need not talk of the spread of hi-tech technology and expensive investments, like most IT providers do. Instead we can think of taking to rural India the very basic core IT applications, which urban educated people often take for granted, thereby making a positive impact on the many lives of rural India through the use of very basic techniques and inputs of the IT that are enough to assist rural India to develop.

1V1C uses readily available applications such as graphic designing, word processor, spreadsheet, presentation, e-mail, Web pages. 1V1C has developed Indian languages solutions through its technology partner Akruti Software. In most of the Indian villages connectivity is not available, so 1V1C depends on inexpensive stand-alone computers instead of heavily investing on connectivity technologies as is done by most of the IT for development projects. Hence 1V1C model is adopted to the existing level of technology, as well as it is adaptable to variety of social and geographic situations. Reliance on existing technologies and alliance with ongoing social movements makes 1V1C village centers cost effective, community supported and immediately beneficial to the villagers.

Philosophy

1V1C is a development strategy for introducing IT in rural areas as a tool for finding solutions for simple problems faced by rural communities. 1V1C has developed new methods of mass IT education and training for village youth and formation of community owned IT Centers. 1V1C strives to facilitate the vertical knowledge flows. It is the flow of subject knowledge held by experts (located at a distance) to the contextual knowledge held by people and vice versa, that can lead to development. 1V1C networks with existing social movements, non-government organizations (NGO) and community-based organizations (CBO). The activities of 1V1C lead to the development of sufficient social capital assets in a given locality making possible the formation of IT Center through community resources. This opens the window of the world to the local community while keeping their basic characteristics intact. It offers them access to the world level cutting age knowledge, which they can use, after appropriate contextualization, for their development. This also facilitates transmission of their traditional as well as and newly developed knowledge to the world community. 1V1C enables the social processes through creation of developmental software. This software is made available in the public domain through as free software.

Methodology

1V1C's efforts have been towards teaching and organizing of village communities to collect information and data relevant to their issues and concerns. The communities where 1V1C works have effectively tackled problems such as rural unemployment through organized and systematic data collection. The information regarding extent and prevalence of unemployment in the villages is used to demand more work under the government's employment guarantee scheme. Local communities have also been taught the value of the principles and techniques of IT such as systematic and reliable data collection and fact finding on their core issues like the below poverty line (BPL) numbers in villages, and demographic information which in turn when used effectively have accelerated people's struggles on issues such as rationing, accessing housing schemes, and old farmer pension schemes.

Another issue was addressed in one of the 1V1C operating villages, where the health of the women and children was badly affected. Here too, the team of people trained by 1V1C engaged in systematic data collection on the occurrence of the problem, which when analyzed and presented to the local health authorities was evidence enough to convince the state health department to organize health camps and check ups and ensure the right to health of community. Such demonstrated attempts have proved the value of reliable data collection and the science of information technology to the local community.

1V1C's work comprises organizing training camps where basic computer skills are taught and it is also used to generate an interest among the local communities on the various uses of IT to benefit their own lives. Interested villagers form CSCs (computer support committees) and learn to use the IT methodology and techniques to try to solve their social concerns. Once successful, the village communities attempt to use the IT to solve many more social issues and gradually move towards forming an IT Center.

The 1V1C process gives village leaders and communities at large a new boost to tackle their issues and since by conception the process is rooted in the involvement of rural communities, it also contributes to leadership development, capacity building, and human capital, resulting in overall social capital building in society.

Information Cooperatives

The whole system operates on a cooperative basis. Any individual or a set of individuals does not own the IT Seva Kendra. The local people are asked to form a cooperative-like structure or are part of an already existing people's organization. Further, a core committee is elected whose membership is by rotation and it is the responsibility of this committee to manage the center. They engage volunteers to manage these centers, and the center usually develops around an existing people's organization already working in that area. The elected CSC, particularly youth and women members are responsible for running and managing the center. 1V1C team plays a crucial role in developing the capacity and ability of these elected people to learn and use information technology to solve community issues, who in turn train and assist the village people to do the same. No one person or groups of persons owns the center or its resources, including the products and learning that are used and developed. The information generated belongs to the community as a whole and hence they have full ownership and access to the same.

Networking

While the democratic way of functioning within villages and districts works through the above mechanism, the idea of 1V1C is to help villages connect beyond themselves to other villages, districts, and maybe even beyond in the near future as and when technology advancement and accessibility grows. The idea is to form a widespread and deep 1V1C network (a social network) wherein knowledge, experiences, and models can be shared across villages and districts and even states, leading to actual self-empowerment and change, by the people and for the people of rural India. The conception of IT Center requires the local population to be convinced of the value of information technology for their villages and districts and hence their willingness to invest in the same. This is to ensure that the local village communities gain greatest stakes in this investment, which works for them.

Women and 1V1C

Information technology can be a decisive weapon for women in their fight for emancipation. In India women are doubly oppressed and in modern times are mostly engaged in some productive occupation. They may be working as farm laborers, household domestic workers, servants in government departments and offices, lunch and eatable suppliers, domestic cigarette rollers, and so forth. Female literacy is lagging substantially behind male literacy. Almost half of the women are illiterate; hence when we speak about illiteracy in India, it is mostly about women. Women are engaged mostly in unskilled work in agriculture as well as in industry that is valued less. They have to face the main brunt of unemployment and poverty. They are deprived of mainstream knowledge, science, and technology. It is a well-known fact that women are paid less than men for similar work throughout the world. Socially women are given secondary status to men.

The Training Curriculum for Women

The training curriculum covers not only the necessary IT tools in the local language, but presentations and discussions on social issues, gender issues, and capacity building exercises to build leadership skills of women volunteers. Social issues are integrated in the skill building exercises. For example, in one of the training programs, participants were asked to provide information on the educational status of girls in their families using a word processor, and they were then taught to make presentations using the same information. This highlighted the problems faced by the girls in completing education, and prompted the male participants to reflect on issues of gender inequality in the family.

Thus, we could experiment and develop the concept of mass community IT training in primary computer applications and computer usage, and integrate this training organically with social thinking and social issues. This process of training saw the village youth gaining confidence and self-esteem. They started thinking about their community's problems and exploring innovative ways of using IT in solving them.

The objective of the training curriculum is to create *IT Enabled Women's Social Networks*. The starting point is gradually training a large number of young women from villages. They are equipped with the necessary IT tools to build leadership skills and social entrepreneurship skills. 1V1C has developed and implemented the concept of *training of trainers* to train large number of village women and community volunteers. Thus, a substantial amount of human knowledge capital is created at the local level. This human capital forms the basis for building of *IT Seva Kendras* (IT Service Centers).

IT Seva Kendra

The IT Seva Kendra's primary role is to link the village community to the world. The Kendra have a symbiotic relationship with the community, with both elements inspiring, nurturing, and drawing from each other. Thus, the Kendra is part of the community and contributes to its growth, while at the same time the community supports the Kendra to grow and be sustainable. IT Seva Kendra becomes a tool, a nucleus for the community to progress and fight against its backwardness and isolation. It is this interactive and incremental process of knowledge transfer that makes the IT Seva Kendras stand apart from the much publicized tele-center models across the world. It is possible to build Women's IT enabled knowledge based rural social networks in backward areas. If IT were successfully and extensively diffused at the village level, it would enable democratic participation of people in a variety of issues. These social nets would form a horizontal structure.

The "Women Only" Program

Fifteen training programs were conducted up to the end of 2003. The first five days training program was held in March 2002 and had 62 participants. These participants represented peasants, landless laborers, women, students, and youth organizations working in 16 districts of Maharashtra. Four training programs were subsequently conducted for the New Bombay youth. Additionally, one training program was organized exclusively for girls and women in the village Murbi, near New Bombay. Altogether 72 boys and girls were trained in these camps. The youth trained at these programs started to assist the trainers in the ongoing training camps. This led to launching of IT Seva Kendras in several districts of Maharashtra state.

In all these training camps, there were women participants. However, we found it necessary to experiment with a "women only" training camp. We provided a "safe", women only, space where young girls/women could come together, express themselves, share, and learn without any inhibitions.

A "women only" five days training program was held at district Wardha in the state of Maharashtra in June 2004. Sixty young women volunteers active in a social movement against illicit liquor brewers and drunkards attended it. They resolved to use IT in the struggle against this problem, which is spreading like an epidemic in rural areas and causing severe social problems. In this camp illiterate women learnt computer applications.

Women March to Seize IT

At a training camp held for Karad, district Satara of the state of Maharashtra, two illiterate village women worked on computer. When Shantabai and Shankuntalabai—two illiterate women from village Goleshwar, district Karad, decided to attend 1V1C program, villagers laughed at them. They wondered how these women could learn computers when they didn't know how to read or write. However, the women vowed to return to the village armed with computer skills. They spent 20 hours a day during the 5-day camp to learn about computers. After the camp, they returned to the village and started teaching other women. Soon the villagers, who were skeptical earlier, approached for help. They were interested in seeking solutions to the sanitation problem in the village. The two women logged on to various Web sites, which offered solutions, like how to construct low cost toilets, etc. Says Shantabai, "Now people don't dare to laugh at us. On the contrary they take us seriously."

At Manvat in Parbhani district, as soon as a computer was installed in the village, a group of curious women, who worked as sweepers, came to see how it worked. It was explained to them how they could use the computer to improve their lives. The women got interested and 30 of them, mostly illiterate, attended a 5-day computer-training camp. 1V1C members advised them to collect all the relevant data about their working conditions and with the help of their school-going children, feed them into the computer. In 2003, on the basis of this information, the women filed cases before the Right to Health Commission in Mumbai for accident and injury claims. Emboldened by the commission's positive response, about 700 women from Manvat town gathered under the leadership of these sweeper women and participated in a protest march to highlight their grievances and demands—lack of medical facilities and housing, unemployment, and pensions for old women workers.

1V1C held three computer-training camps for rural people at Agroli in New Bombay in May 2004. The first camp included men and women who were trained as trainers by the seven women of Murbi village. This batch further trained 138 women from different parts of Maharashtra. The batch learnt to use the keyboard in the local language. Besides, they also learned the art of public speaking, which was found essential for voicing their grievances.

Using IT for Women's Issues

Extensive surveys have also been conducted on the impact of the dowry system resulting in increasing violence against women leading to bride burning, desertions, and bigamy. In Maharashtra there are over 600,000 deserted women, most of them living below the poverty line.

A database of more than 30000 domestic women workers is created and 1V1C has developed a Domestic Women Workers' Software (KamwaliBai software) to analyze the data. This software is useful in formulating and resolving complex problems faced by these women.

CHALLENGES AND FUTURE TRENDS

1V1C proposes to take up challenging job of development of full-fledged training module for illiterate women to teach IT literacy, which could lead to primary literacy. The second challenge is to link women's social network with that of the self-help groups (SHG) (as part of micro credit movement). Third task is to link with elected women representatives at the grass root level. 1V1C also expects to deal with issues faced by slum dwelling women from cities and towns. Domestic Women Workers' Software is a step in that direction.

CONCLUSION

From beginning 1V1C has always kept the gender question on the forefront. Learning of the 1V1C campaign shows that gender issues and women's participation should be taken up from the very inception and special attention should be given to nurture the leadership of women activists.

Keeping computers at the center stage of the entire process is very much successful so far and has shown definite results. Training in skills, leadership and social entrepreneurship has definitely helped. The spontaneity of the whole process is encouraging. Young women activists are coming up to take responsibility for running of the IT Centers on voluntary basis. A group of women trainers have emerged who are conducting training camps not only in their own villages but elsewhere as well. Women's leadership is proving to be an asset for the entire communities.

Armed with databases, facts and figures, and quantitative analytical tools in their hands women feel more confident to press and lobby for their demands and achieve greater successes. They are able to analyze their problems at micro as well as macro levels, which help them formulate their demands in a better and effective way. It also helps them to acquire various types of skills, and develop a rational, scientific outlook that is necessary for their advancement and leadership development.

KEY TERMS

1V1C: One Village One Computer Campaign in India.

Akruti: A brand name of Indian language software. (Literal meaning of Akruti is graphic figure.)

CBO: Community based organizations.

CSC: Computer Support Committees formed around 'IT Seva Kendra' to work on specific community issues and consisting of village volunteers.

IT Seva Kendra: It is a community owned cooperative entity that nurtures learning and innovation in the community. IT Seva Kendra is a window to the world for the village community through whom they can access cutting edge knowledge, modify and use that for their own benefit, publish their own implicit and local knowledge and share their aspirations to the world.

KamwaliBai Software: Proper name of the domestic women workers software developed at 1V1C (Literal meaning, Kamwali=domestic worker, Bai=woman).

IT Work in European Organisations

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INTRODUCTION

Employment in IT professions has increased greatly in recent years. Aside from the crisis of the dot.com crash in 2001, there has been significant growth in hardware manufacturing and particularly in software and IT services. In the European Union, employment in computer services doubled between 1997 and 2001, and grew by 10% in 1998 alone.

This pattern has not been matched by a parallel increase in women's participation in IT work. Women's employment in IT has remained resolutely around an average of 28% across the EU; in the professional areas of IT work (as opposed to clerical and other non-professional occupations), women made up only 17% in 2001 and their representation is in fact declining (Millar, 2001; Millar & Jagger, 2001; Webster & Valenduc, 2003).

It is an issue of some concern to policy makers, employers, and indeed gender equality practitioners that, despite more than 20 years of attempts to attract women into this comparatively well paid and privileged area of the labour market, women remain such a small and, worse, apparently declining, proportion of IT professionals. Why are women still so poorly represented in IT professions in the EU? What is the nature of working life in IT and what are the working conditions like? Why have more than 20 years of initiatives to get more women into technology professions had so little apparent impact?

BACKGROUND

This article summarises the results of a European research project which attempted to answer these questions, focussing on the situation in seven EU countries: Austria, Belgium, France, Ireland, Italy, Portugal, and the UK. Entitled "Widening Women's Work in Information and Communication Technologies" (WWW-ICT), the project combined biographical interviews with female and male IT professionals with case studies of employing organisations in the IT services sector, and was conducted between 2002 and 2004.

As Table 1 shows, women still made up less than one-fifth of IT professionals in these countries in 2001, with the exception of Ireland. Indeed, IT professionals in Europe are typically male, young (in their mid twenties), and without domestic responsibilities. The majority of women working in the sector are also young and childless. These employees are among the most favoured in the labour market. Wages are relatively high, and many IT workers are paid in a combination of cash and share options. Moreover, employment contracts involving individually agreed pay, terms and conditions replace the fixed pay grades traditionally found elsewhere. Performance-related pay or bonus schemes are common (Valenduc et al., 2004).

Employment is predominantly on full-time permanent contracts. Part-time employment and flexible working arrangements are very unusual, though

Table 1. Employment in IT professions (ISCO213) in the WWW-ICT countries, 2001 (thousands of employees)

	Female	Male	% Female
EU15	265.4	1264.8	17%
Belgium	8.8	49.7	15%
France	50.3	250.3	17%
Ireland	6.0	14.6	29%
Italy	(2.0)	9.0	(18%)
Austria	(1.4)	8.8	(14%)
United Kingdom	63.5	351.1	15%

Note: Data in brackets and on Portugal are considered unreliable by Eurostat
Source: Eurostat, data from the Labour Force Survey, quoted in Valenduc et al. (2004)

they are more common among female employees. Full-time working often means long working hours. Project work can be unpredictable, involving tight deadlines, so evening and weekend working is common. Working hours often exceed those laid down in employment contracts, though overtime is rarely paid for. Employees can arrive at and leave work according to their own preferences, but this tends to translate into long hours, which are often self-imposed (Mermet & Lehndorff, 2001). Consequently, in France, for example, the implementation of the 35-hour working week has been very problematic in this sector; even the imposition of the legal limit of 39 hours was fraught with difficulties. Given these kinds of working patterns, it is unsurprising that the sector employs predominantly young men able (and apparently willing) to provide the total availability needed by their employers.

In employment and industrial relations, the IT sector is a world away from traditional companies. Trade union membership and collective bargaining are weak, and there is corporate antipathy or hostility to unions. There are particularly low levels of unionisation on U.S. owned green-field sites. The fact that computer services employees are young, highly skilled, and up until recently, operating in a favourable labour market, also militates against trade unionism. Even in countries with strong collective bargaining frameworks (for example, Belgium, France), union membership is low and employment relations are highly individualised. Pay and conditions are agreed bilaterally, and often kept confidential from other employees. Pay is based partly on performance assessed through individual appraisals carried out periodically by line managers. Performance systems, bonus systems, and stock options have been relatively lucrative for IT professionals, but since the 2001 downturn, they have been more vulnerable to the vicissitudes of the stock and labour markets. Communication—not consultation—is carried out on a one-to-one basis between employers and employees (Valenduc et al., 2004). This is the context within which we attempt to understand the under-representation of women in the professional areas of IT.

MAIN THRUST OF THE ARTICLE

The Organisation of Work

IT companies tend to be flat structures with few hierarchical layers. It is common for IT professionals to be organised into project teams, led by a project manager. These teams may be temporary, operating only for the duration of the project, or semi-permanent. They may consist of interdependent workers with complementary skills, or individuals with the same skills working independently of one another within the team. Women are often undervalued in interdependent teams, where their technical skills are taken for granted relative to the interpersonal or team-working skills of their male counterparts (Woodfield, 2000).

Working Time and Work-Life Balance

IT work is predominantly full-time work. Much of it is deadline-driven, particularly where it is governed by project timetables or client demands. Long working hours are the norm, as is availability to the company and to clients. Hot-desking and client-based working are common among IT professionals, as is home-based working, with systems provided by employers. This can extend working hours; it is common for IT professionals to work at "unsocial" working hours—late at night after children are in bed, or very early at weekends.

Working hours? They are exaggerated because no one can say a simple "no" to the client. This is the company's policy. You have to give all your availability and energy to the firm: working overtime and sometimes also at home after work. (Marta, Italian IT company, quoted in Webster [2004] Case Studies of Work Organisation [WWW-ICT Deliverable No. 7], www.ftu-namur.org/www-ict)

Part-time working is very unusual in this sector, and is principally done by women returning from maternity leave. It has been found to severely limit progression prospects, with companies demoting and marginalising part-timers. Other family-friendly working arrangements are rare in European IT companies, some of which regard families as problems that divert employees from their work. Work-life balance policies may be used in a tight labour market to attract a wider pool of job applicants. In recessionary conditions, there is no need for such arrangements.

Informal flexible working arrangements do exist; employees are often allowed by their companies to take time off when they need to, as long as their work is done. In practice, this usually means more time spent at work, rather than less. In general, reconciliation between professional and private life is difficult for employees (of both sexes) in IT professions (Webster, 2004). It is not clear whether the industry attracts young, single people because they are the only employees who can manage these types of working time demands, or whether the working time arrangements have evolved in response to the type of employees who predominate in the sector.

Employee Development and Women's Progression

Most IT professionals in Europe have first degrees, and many have higher degrees. On-the-job learning and skills maintenance are considered critical in the IT professions as the means by which professionals build their knowledge of the most recent technical developments. Business and management skills take on increasing importance in the career development of IT professionals, and technical skills become less prominent.

In large companies, there are employee development opportunities, particularly in comparison with smaller organisations which have fewer resources for this. However, increasingly there is a tendency across the sector for training and development to be individualised—for training to be managed and conducted by the individual employee using computer-based learning, the Internet, and interaction with peers, with low levels of intervention by the employing organisation. The individualisation of training departs from formal, supply-driven systems, focuses more on the individual learning requirements of employees, and places much more autonomy in their hands. However, it can be difficult for employees with domestic commitments to find time for learning outside of normal working.

When I see IT professionals, programmers in fact, they have to constantly continue training. I think that that side of the job is difficult to balance with family life. In fact, those who do so aren't married, and don't have kids. (Computer graphic artist, Belgium, quoted in Webster [2004] Case Studies of Work Organisation [WWW-ICT Deliverable No. 7], www.ftu-namur.org/www-ict)

The IT sector is a relatively privileged place for women to work. Pay and autonomy are high, and there are considerable opportunities for progression, along two basic career trajectories: a technical career path and a management career path. The latter is the most common career pattern for IT professionals, and includes possibilities to move into project management, team management or business management. Employers often assume that women are more comfortable in management than in technical roles. In fact, women are very much attracted to technical work and enjoy doing it, because it is "creative." Creative work can mean coding and programming, designing and developing a Web site or service, or developing an overview of a project through project management work. Solving problems is one of the most satisfying aspects of the work. Yet women are sometimes directed away from technical work and towards project or business management, on the assumption that this sort of work is particularly closely compatible with their assumed interpersonal and organisational skills.

Nevertheless, women remain significantly under-represented in managerial and particularly executive positions in IT (see also Panteli, Stack, & Ramsey, 2001; Tijdens, 1997). First, informal and opaque progression arrangements persist in the IT professions. These include "promotion through visibility," in which participation in informal social activities (football clubs and pub evenings, for example) raises visibility and so confers advantages on certain employees, usually men (see also Tierney, 1993). The WWW-ICT study also found direct discrimination against women by male managers, on the basis of assumptions about their availability for, and commitment to, their work, particularly on and after maternity. Panteli, Stack, and Ramsey (2001) similarly report employers giving women less responsibility and allowing their marginalisation in organisational cultures.

Women also commonly understate their own skills and knowledge, and deselect themselves from eligibility for promotion opportunities. Self-advocacy, although in principle empowering, can disadvantage those without strong self-confidence, women in particular. It can also be problematic if their self-confidence, rather than their other skills and qualifications, are the basis on which employees are assessed and promoted.

Good employers understand the need to implement consistent policies for recruitment, training, appraisal and development, in order to improve women's recruitment and, crucially, their retention in IT. Such coherent policies communicate clear messages to women about potential career routes, and provide the infrastructural channels through which they may move. Some companies also run "fast track" progression systems in conjunction with specific schemes for developing women, through mentoring and other confidence-building initiatives. In general, organisations with awareness of how gender operates within and beyond their own spheres are most likely to recruit and promote women into senior positions. However, even the most equality-conscious companies have internal conflicts between their equality agendas and their other organisational practices, particularly during periods of restructuring. Women IT professionals seem to leave the profession in disproportionate numbers at maternity, and then again in mid-life; either they are disproportionately targeted by organisational redundancy programmes or they voluntarily leave their jobs in search of other working arrangements, just at the point when they might be entering senior management and executive positions (George, 2003).

A major obstacle to women's representation in IT professions—one which cuts across very many well-intentioned corporate equality programmes—lies in the working time arrangements and culture of the profession. Long working hours particularly affect people in technical roles, who have to be available to their employers and their clients, and those in senior management. Moreover, they are part of the IT working culture even in countries which do not otherwise have a "long hours culture", and in which the European Working Time Directive has been adopted without quibble. Even in companies with strong gender equality programmes, promotion into senior positions appears to depend upon the ability and willingness to work long hours. This transmits implicit messages from senior executives to more junior staff that such working patterns are necessary for career advancement—messages which fundamentally contradict those that they wish to convey through their other equality initiatives. This may discourage people—of both sexes—who are unable to engage in it from pursuing promotion possibilities in their organisations. In general, of course, it is women who are primarily disadvantaged by long working hours.

FUTURE TRENDS

Since the early 1980s, when computing first emerged as a significant new area of work, there have been widespread attempts by public authorities, voluntary organisations and private sector employers, to attract and retain women into computing professions. Most of these initiatives were informed by the idea that "adding women in" to technological jobs would address the exclusion of women from technology (Henwood, 1993). The context within which these initiatives were pursued—wider corporate strategies and practices concerning organisational and technological changes—were often, however, overlooked and, consequently, many initiatives were ineffectual.

Developments in the IT sector at the beginning of the 21st century have created a difficult environment for improving women's representation. The sector has undergone an almost unprecedented downturn. Over 100,000 employees and contractors have been made redundant in the UK since the middle of 2001 (E-Skills Bulletin, 2004), organisations have been restructured, while programming functions are now routinely outsourced to third countries (India, Israel, Romania, for example). Many of these events are extremely detrimental to both women's numerical representation and the quality of their working lives in IT.

Hacker (1989) noted that the process of organisational and technological change in AT&T in the 1980s ultimately undermined her attempts to pursue equality initiatives. Similarly, restructuring programmes in European IT companies are proving extremely hostile to more localised, decentralised equal opportunities programmes. Recessionary conditions (such as those following the dot.com crash of 2001) seem to prompt, in the large corporations at least, a reassertion of highly centralised decision-taking, authoritarian and bullying management styles, an abandonment of corporate commitments to equality and a return to conventional fiscal performance measures which allow no leeway for longer-term projects.

In this context, training and development budgets are commonly cut back, with particularly negative consequences for women, who find generally it difficult to pursue these activities in their own time. In corporate redundancy programmes, middle-aged women may be more vulnerable than their male counterparts. Competitive pressures wrought by an economic downturn cut across well-intentioned and well-structured equal opportunities strategies and are ultimately more influential on corporate behaviour. The retrenchment by corporations also reduces the pressure on them (at least during periods of skills shortage) to draw from a wide a portion of the labour market as possible.

Nor are these merely temporary responses to contemporary competitive conditions. A profound change in the conduct of IT organisations is taking place, and this is gaining ground across the European IT sector. Despite rhetorical emphasis on teams and team working, the organisation of both employment and work processes are becoming increasingly individualised. In HR management, there is increasing emphasis on employees' personal qualities, including self-direction, self-management and self-advocacy, and on placing responsibility for employee development with the individual rather than the organisation. Collective bargaining is being displaced by the setting of pay and employment terms and conditions on a unilateral basis between management and employee. Trade unionism is discouraged by employers and seen as irrelevant by many employees.

CONCLUSION

Employment conditions in IT professions are not woman-friendly. Long working hours, lack of structured training and development, promotion systems based on availability and visibility, and persistent chauvinistic assumptions about women's commitment to the work, which underpin management practices, are all factors that have combined to prevent women from progressing in the IT professions. Equality and diversity programmes have admittedly attempted to address these issues, often through adjusting recruitment, training and development systems, improving progression systems and modifying working time demands. This was feasible when organisations were motivated to improve their record on women's participation in the IT professions, through skills shortages or tight labour markets. However, when this is less of an incentive and as the sector becomes increasingly governed by cost cutting through new forms of efficiency management, the project of improving the conditions of women's participation in IT is sacrificed to the cause of improving shareholder value through fiscal performance improvements. This exemplifies the profound tension between the objectives of equality and social cohesion with the imperatives of the market, a tension which may explain the apparently negligible impact of initiatives to get more women into technology. With IT services becoming increasingly competitive, globalised, and rationalised, what is the longer-term scenario for women in IT? This is a question for future cross-national comparative research.

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KEY TERMS

35-Hour Working Week: Law enacted in France in 1998 which provided for the introduction of a statutory 35-hour week from January 2000 (2002 for smaller companies). The legislation was relaxed in March 2005.

Business Management: In matrix organisations, management of separate businesses within the organisation is devolved, and involves overall responsibility for the financial, marketing, planning, human resource management and project implementation tasks involved in the business.

Biographical Interview: Interview which aims to understand a person's biography or developmental trajectory, covering significant episodes, important events and the role of relevant others.

Development Work: Development work involves the programming of software, at different levels of complexity.

Dot-Com Crash: Sudden crash in the share prices of internet companies in 2001 after return on investments were not met by many companies, with repercussions throughout the IT sector.

European Working Time Directive: The European Working Time Directive was first adopted in 1993, and aims to ensure that workers are protected from working excessively long hours, having inadequate rest or disrupted work patterns. It includes provision for a maximum 48 hour working week.

Project Management: General term covering a group of jobs involving leading and managing a team charged with a specific set of tasks.

IT Workforce Composition and Characteristics

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INTRODUCTION

Women are under represented in the information technology (IT) workforce. In the United States, although women make up about 45% of the overall labor force they make up only about 35% of the IT workforce. (Information Technology Association of America, 2003, p. 11). Within IT, women's representation declines as one moves up to higher-level occupations. While women are relatively more numerous among data entry keyers and computer operators, they are relatively less likely to be found in high-level occupations like systems analysts and computer programmers.

The relatively low representation of women in IT fields parallels a broader pattern of gender differentials in other scientific and technical fields. In all science, technology, engineering, and mathematics fields combined, women held 25.9% of jobs in 2003. Women's representation varies widely by sub-fields, however; 65.8% of psychologists and 54.6% of social scientists are women, but only 10.4% of engineers, and 37.4% of natural scientists (Commission on Professionals in Science and Technology, 2004, p. 2).

Over the course of the past 100 years, there has been a dramatic change in women's economic role. In 1900, only one in five adult women worked outside the home, and most of these were young and unmarried (Goldin, 1990). Since then, male and female labor force participation rates have tended to converge. Between 1900 and 1950 there was a gradual expansion of women's labor force participation. After World War II the pace of change accelerated sharply as more married women entered the labor force. During the 1960s and early 1970s a series of legal changes significantly broadened protection of women's rights ending essentially all forms of overt discrimination (Fuchs, 1988; Long, 2001, p. 9-10). The removal of these barriers in combination with the availability of cheap and reliable birth control technology greatly facilitated the entry of women into higher education, and technical and professional positions (Goldin & Katz, 2002).

Nevertheless, as the figures cited at the outset reveal, women's participation in IT and other technical fields has not increased as rapidly as it has in less technical fields. And in striking contrast to the general trend toward increasing female participation in most areas of the workforce, women's share of the IT workforce in the United States has actually declined over the past two decades. Any effort to explain gender differences in IT must begin with an understanding of how the number, characteristics, and pay of women in IT have evolved over time, and across different sub-fields within IT. This chapter provides a foundation for this analysis by documenting recent changes in the number of women employed in IT, their demographic characteristics, and relative pay.

BACKGROUND

A discussion of the gender composition and characteristics of the IT workforce must begin by clarifying what is meant by IT. This is difficult because IT encompasses a broad array of products and activities related to computing and communications in the modern economy (Freeman & Aspray, 1999, p. 29-31). Although many workers make use of IT in their jobs, most studies agree that only those workers who are responsible for creating IT hardware and software should be included in the IT workforce, while those who are primarily users of these products should be excluded (In addition to Freeman & Aspray, see Ellis & Lowell, 1999, p. 1; National Research Council 2001, p. 44-54).

Whatever conceptual definition one adopts, however, its application is limited by the classification schemes used by agencies engaged in collecting data on different elements of the workforce. In what follows we will focus on those IT occupations that are enumerated in the Bureau of Labor Statistics' Current Population Survey (CPS). The CPS data cover computer systems analysts, computer programmers, operations and systems researchers, computer operators, and computer operators supervisors. These occupations constitute more or less what the National Research Council (2001, p. 48) has termed "Category 1" IT occupations: those involved with the creation of new products, services and applications. CPS data do not permit us to measure or describe the characteristics of the National Research Council's "Category 2" occupations: those involved in the application, adaptation, configuration, support or implementation of IT products or services (National Research Council 2001, p. 49). Because occupational titles do not adequately capture the IT content of the support activities of many of the technicians and other occupations included in this group it is more difficult to adequately measure its size or demographic characteristics.

THE SIZE, COMPOSITION, AND CHARACTERISTICS OF THE IT WORKFORCE

An Overview of IT Labor Market Conditions

The rapid and sustained decline in the cost of computers over the past two decades has been a prominent factor in the reorganization of work in the United States. Between 1984, near the beginning of the personal computer era, and 2001 the quality-adjusted price of computers fell at an average annual rate of 16%, resulting in an 18-fold drop in price (U.S. Department of Commerce; cited in Weil, 2005, p. 263). As personal computers diffused into widespread use, mini-computers vanished from the market, and sales of large corporate mainframes languished. Shifting markets and the changing needs of users resulted in significant shifts in the software industry. Growing consumer markets fostered growth of the packaged software industry, and created whole new categories of software. Since the early 1990s, the spread of the internet and the increasing importance of networked computing have initiated a new round of changes in the IT industry (Mowery & Rosenberg, 1998). Adding to demand pressures during the late 1990s was global concerns about the Y2K problem.

Strong demand for IT professionals contributed to a rapid expansion of the IT workforce and rising relative pay. From 1983 to the peak of the technology boom in 2000, the IT workforce more than doubled in size, increasing from 1.47 million to 3.13 million persons. To put this in perspective, during this same period the total U.S. labor force increased by just 34%, from 99.5 million persons to 132.2 million persons (these figures and all the subsequent statistics are derived from the authors' computations based on data from the Current Population Survey's merged outgoing rotation groups). Despite the loss of more than 200 thousand IT jobs in the next two years, the IT labor force in 2002 was still 96% larger than it had been in 1983. To draw more workers into IT jobs relative pay had to rise substantially. In 1983 the median hourly wage of full-time IT professionals was about 20% above that for all non-IT occupations. By the late 1990s the wage gap had more than tripled, so that IT professionals earned more than 60% more than did workers outside of IT.

The growth of IT employment coincided with important changes in the type of jobs performed by IT professionals. Most obviously, as the importance of mainframe computers diminished, the number of computer operators fell substantially. From a peak of 962 thousand computer operators in 1986, the number of computer operators had fallen to just over 300 thousand by 2002. From being close to half of all

IT professionals in the mid-1980s this category of workers fell to under 11% of the IT workforce by 2002. Offsetting this decline was the extremely rapid growth in the number of computer systems analysts and scientists. This segment of the IT labor force grew from 273 thousand in 1983 to more than 1.7 million in 2002. By the latter year, this category of workers constituted over 60% of all IT professionals, up from less than 20% in the early 1980s.

Gender Differences in Employment, Earnings, and Hours

Contrary to the trends in most of the U.S. labor force, the share of women in the IT workforce has declined substantially over the past two decades. In 1983 women made up slightly more of the full-time IT workforce (43%), than they did of all full-time non-IT workers (40%). By 2002, however, the share of women in IT had fallen sharply, dropping to 30%, while the share in the non-IT workforce had risen to over 49%.

The decline of female representation in IT is troubling, but much of this decline can be accounted for by the declining number of computer operators. Removing this group, the share of women in other IT occupations has remained quite stable at around 28 to 29% of the workforce. Thus the falling share of women reflects the growing importance within IT of occupations that have traditionally been dominated by men (and, implicitly, the failure of more women to enter these traditionally male-dominated fields).

As is true more generally, women in IT earn less than men do. Indeed the gender wage gap in IT is quite similar to that in the rest of the labor force. In 2002, women in IT earned 82.5% as much per hour as men, while in the rest of the labor force they earned 82.8% of what men did. Average pay for computer operators is considerably lower than for other IT occupations, so the concentration of women in this field tends to magnify the gender pay gap. Excluding computer operators, women earned about 86% of what men did in the remaining IT occupations. This pay ratio has been approximately constant over the past two decades, increasing only from 83% in the early 1980s.

IT occupations are often characterized as involving long hours and requiring a significant time commitment. One reflection of this is the higher proportion of both men and women in IT who work full time. In 2002, 95% of men and 91% of women in IT worked full-time. In non-IT jobs 87% of men and just 73% of women worked full-time. As a result the average woman in IT worked more than three additional hours per week than did the average woman in a non-IT job (39.5 hours compared to 36.2 hours). The longer hours in IT may be one factor that discourages women—especially those with young children—from going into or staying in the field.

Gender Differences in Demographic Characteristics

Table 1 summarizes a variety of demographic characteristics for IT and non-IT occupations broken down by gender. As the table reveals, IT workers tend to be somewhat younger than the rest of the labor force. This is especially true for male IT workers, who are on average more than three years younger than their non-IT counterparts, but female IT workers are also younger than women in non-IT

Table 1. Selected demographic characteristics of information technology and non-information technology workers, 2002

	Information Technology		Non-Information Technology	
	Male	Female	Male	Female
Average age	37.9	39.9	41.0	41.0
Percent with Bachelors Degree	50.0	39.4	19.4	21.0
Percent with more than Bachelor's degree	19.0	13.6	10.5	10.1
Percent married, spouse present	64.9	53.4	64.7	54.3
Percent never married	26.2	27.4	22.6	22.7
Percent living with one or more of their own children	58.2	54.2	56.3	53.8

Source: Authors' calculations from Current Population Survey merged outgoing rotation group data occupations. Reflecting the high levels of training needed to enter IT professions, many more workers in IT jobs have bachelors degrees or higher. Fully 2/3 of men and more than half of women in IT occupations have at least a Bachelors degree, compared to 30% of men and 31% of women in non-IT occupations.

In contrast to the differences in age and education levels, the percent of workers who are married with spouse present is relatively similar between IT and non-IT occupations. It is true, however, that IT workers are somewhat more likely to have never been married than is true for those in non-IT occupations, but it seems likely that this is due to the fact that IT professionals are younger than the non-IT workforce. Reflecting the fact that married women are still more likely to exit the labor force than are married men, within both groups working women are less likely to be married with their spouse present than is true for men. On the other hand, the proportions of workers with one or more of their own children present in the household is quite similar between IT and non-IT occupations, suggesting that this pattern is similar for both IT and non-IT workers.

FUTURE TRENDS

After nearly two decades of explosive growth and transformation, the expansion of the IT workforce came to an abrupt halt with the collapse of the technology bubble in 2001. For the past several years the number of IT workers has been declining. This decline is generally expected to be temporary, and most forecasts anticipate that employment in IT occupations will continue to grow more quickly than in the labor force generally, though the differential is unlikely to be as large as it was in the past (U.S. Bureau of Labor Statistics 2004).

In the past few years there has been increasing concern about the role of off shoring in IT job losses. There have been numerous reports of companies exporting technical support and programming jobs to suppliers in India, China, and other low-wage countries with well-educated labor forces. Given the large international differences in wages, shifting some tasks to Asian countries is an attractive option for U.S. companies seeking to cut labor costs. But it is important not to overstate the potential impact of this trend. Off shoring is most effective when the tasks to be performed have been routinized. These, in turn are the sorts of jobs that are most in-danger of being automated in any event. Jobs requiring specialized knowledge of business practices and discretionary decisions are likely to continue to be performed in proximity to customers, thus ensuring that the vast majority of higher level IT jobs, such as those performed by systems analysts, will remain in the United States (Edwards, 2004).

While this suggests that IT job losses in the United States due to off shoring may be small, it also suggests that the composition of IT jobs will remain biased towards those high skilled jobs that contain relatively few women. Thus prospects for increasing the representation of women in IT appear relatively bleak. If relatively few women have been drawn into the rapidly growing field of computer systems analysts and scientists during the period of rapid expansion in employment, opportunities for women are likely to remain limited in the future as aggregate growth slows. More research is needed to understand why women have tended to avoid these higher-level IT jobs, and to identify those dimensions of education, hiring, and retention that have produced such large gender gaps in representation.

CONCLUSION

During the past half-century gender differences in the labor market have closed substantially. Overall, women's labor force participation behavior has come increasingly to resemble that of men, so that today women constitute approximately half of the U.S. labor force. Although a gender earnings gap remains today, the size of this gap has been reduced considerably, and after accounting for differences in education, experience, and other characteristics it is smaller than indicated by unadjusted comparisons.

Set against the background of these broad labor market changes, gender differences in Information Technology are striking. While total employment in IT has grown rapidly, women's share of employment across all IT occupations has fallen substantially over the past two decades. The absence of women does not reflect an absence of financial incentives. Gender pay gaps in IT have paralleled those in the workforce generally. Since pay in IT occupations has grown quite quickly women could realize significant financial rewards from moving into IT occupations.

Although the growing gender gap in IT employment is largely due to changes in the mix of IT occupations that has increased the numbers of computer systems analysts and scientists, the fact remains that women hold less than 1/3 of such jobs today, about the same proportion as they held 20 years earlier. The persistent under representation of women in these higher-level IT occupations is an as yet unexplained phenomenon that requires further study.

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KEY TERMS

Current Population Survey: A monthly survey of approximately 50,000 households administered jointly by the U.S. Census Bureau and Bureau of Labor Statistics to gather information about employment status and demographic characteristics of individuals.

Full-Time Worker: An individual who works an average of 35 or more hours per week.

Labor Force Participation: In the United States labor force participation is assessed based on the response to questions asked as part of the Current Population Survey. An individual is said to participate in the labor force if he or she is over 16 and either performed paid work, or engaged in a variety of job-seeking activities in the week prior to the survey.

Labor Force Participation Ratio: The ratio of the number of workers participating in the labor force to the total population, aged 16 or over.

Off-Shoring: The practice of relocating jobs previously performed in the United States to other, countries; typically low-wage Asian countries like China and India.

Technology Bubble: The period of time during the mid- to late-1990s when investment in internet based companies boomed. The precise dating of the beginning of the bubble is difficult, but it is generally agreed that the bubble came to an end when U.S. stock markets reached a peak in early 2001.

Wage Gap: The difference in pay between two groups of workers, such as Blacks and Whites, or Men and Women. The wage gap can be measured either in absolute terms or as a ratio or percentage difference.

IT Workplace Climate for Opportunity and Inclusion

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INTRODUCTION[1]

Our program of research is rooted in organizational psychology and employs a climate perspective to understand women's experiences in the information technology (IT) workplace. An appropriate climate can help a workplace effectively attract and retain a diverse employee base (Miller, 1998). Climate consists of employees' perceptions of workplace events, practices and procedures, including which behaviors are expected, supported and rewarded (Schneider, Wheeler, & Cox, 1992). Climate requires a referent to have meaning, and there is not a single climate within an organization. For example, there are climates for safety, innovation and customer service. Our focus is climate for opportunity and inclusion (Hayes, Bartle, & Major, 2002).

Climate for opportunity is defined as an individual's overall perception of the fairness and inclusiveness of the workplace in terms of the processes used to allocate opportunities and the resulting distribution of opportunities. Opportunities include hiring, assignments, promotions, pay, power, authority, awards and training. By creating an *inclusive* work environment, employers can capitalize on the benefits of diversity. Although definitions vary in this emerging literature (cf. Miller, 1998; Mor-Barak & Cherin, 1998; Pelled, Ledford, & Mohrman, 1999), most agree that inclusion means ensuring that everyone in an organization's diverse workforce feels a sense of belonging, is invited to participate in important decisions and feels that his or her input matters. Exclusion leads to turnover, reduced organizational commitment and decreased job satisfaction (Greenhaus, Parasuraman, & Wormley, 1990). Moreover, prospective employees are more likely to be attracted to inclusive organizations (Powell & Graves, 2003).

Our research suggests that three key factors predict inclusive climate: (1) good working relationships between supervisors and IT employees, (2) supportive coworkers, and (3) an organizational culture that supports balance between one's work life and personal life (Major, Davis, Sanchez-Hucles, & Mann, 2003). In turn, IT employees respond to an inclusive climate with better performance, greater job satisfaction, heightened commitment and increased likelihood of remaining with the current employer and staying in the IT field (Major et al., 2003). In this article, we focus on the gender differences and similarities regarding IT employees' perceptions of: (a) inclusion and climate for opportunity, (b) workplace relationships, and (c) satisfaction and commitment.

BACKGROUND

Research Methodology

Our Web-based survey was completed by 916 IT employees from 11 companies. (See Major & Germano, 2006, for a detailed description of participants and measures.) Due to missing data, the sample size for most analyses reported here is 872; exceptions are noted.

Key Research Findings: Gender Similarities and Differences

In comparing men's and women's experiences in the IT workplace, we found a number of similarities and differences. Means and standard deviations, along with the results of independent samples t-tests and Cohen's effect size (*d*), are presented in Table 1. We used the results of t-tests to estimate mean differences between the responses of men and women. Because our sample is large and the significance of the *t* statistic is influenced by sample size, we also calculated *d*, which is uninfluenced by sample size, to estimate the magnitude of the gender effect. These two statistics together tell us whether there is a significant difference between men and women (*t* statistic) and how meaningful the magnitude of this difference is (*d* statistic). The sign of the effect size (positive or negative) merely reflects the direction of the gender difference (positive effect size when the mean score for men is greater than the mean score for women).

Inclusion and Climate for Opportunity

Men and women did not differ on the belonging and participation dimensions of inclusion, suggesting that both feel equally welcome in the IT work environment and both are equally likely to be a part of decision making. However, when it comes to having an influence in the environment (i.e., feeling that one's contributions actually have an impact), men were significantly higher than women. Men were also more likely to perceive a positive climate for opportunity than women. That is, women were less likely than men to feel that opportunities are provided without regard to gender and ethnicity.

Workplace Relationships

Effective interpersonal relationships allow individuals to feel adjusted and anchored in work contexts that might otherwise be overwhelming and unwelcoming (Kahn, 1996). Employees' relationships with their mentors, coworkers and immediate supervisors are particularly important.

Mentors

Mentors are senior individuals with advanced expertise and knowledge who assist in providing upward support and mobility to their protégés' careers (e.g., Wanberg, Welsh, & Hezlett, 2003; Ragins & Cotton, 1999). Mentors typically offer both career development and psychosocial support. Having a mentor has a positive influence on numerous career outcomes for protégés. Compared to their nonmentored counterparts, those with mentors have higher job performance ratings, are promoted more frequently, have higher satisfaction with their jobs and have higher incomes (e.g., Allen, Eby, Poteet, Lentz, & Lima, 2004; Ragins & Cotton, 1999).

In general, research shows that men and women have equal access to mentors (O'Neill, 2002). In our study, women were actually more likely than men to report having at least one mentor. However, this finding may be due to gender differences in conceptualizing mentoring. Follow-up focus group discussions with men and women in our sample (see Major & Germano for a description) suggested that, despite being provided with the same definition of mentoring on the survey, women may have had a broader interpretation of mentoring (i.e., any helping behavior) than men. Among men and women who reported having at least one mentor, there was not a statistically significant gender difference in level of satisfaction with mentoring received, although the effect size suggests that men may be less satisfied with mentoring than women.

Coworkers

Research shows that supportive coworkers are beneficial in a variety of ways. Coworker support is associated with reduced stress, greater organizational commitment, higher job satisfaction and re-

Table 1. Gender comparisons: Means, SDs, T-statistics & Cohen's effect size

Dependent Variable	Men			Women			Independent samples t test			
	N	*Mean*	*SD*	*N*	*Mean*	*SD*	*t*	*df*	*p*	*d*
Inclusion:										
▪ Belonging	530	4.17	0.72	344	4.14	0.77	0.57	872	0.57	0.04
▪ Participation	530	4.14	0.73	344	4.05	0.82	1.79	872	0.07	0.12
▪ Influence	530	3.83	0.87	344	3.67	0.93	2.72	872	0.01	0.19
Climate for Opportunity	530	4.51	1.09	344	4.32	1.10	2.39	872	0.02	0.17
Workplace Relationships:										
▪ Affective Coworker Support	530	3.84	0.73	344	3.91	0.75	-1.40	872	0.16	-0.10
▪ Instrumental Coworker Support	530	3.99	0.75	344	4.09	0.69	-1.98	872	0.05	-0.14
▪ Leader-Member Exchange	530	3.48	0.92	344	3.57	0.93	-1.46	872	0.14	-0.10
▪ Currently Being Mentored	519	0.47	0.50	333	0.61	0.49	-4.16	850	0.00	-0.29
▪ Satisfaction with Mentoring	187	4.03	0.77	145	4.16	0.63	-1.65	330	0.10	-0.18
Satisfaction:										
▪ Overall Job Satisfaction	530	5.07	0.98	344	5.18	0.99	-1.73	872	0.08	-0.12
▪ Satisfaction with Supervision	530	5.11	1.52	344	5.27	1.48	-1.58	872	0.11	-0.11
▪ Satisfaction with Job Security	530	4.62	1.66	344	4.85	1.45	-2.10	872	0.04	-0.15
▪ Satisfaction with Pay	530	4.79	1.29	344	4.94	1.27	-1.74	872	0.08	-0.12
▪ Satisfaction with Social Environment	530	5.60	0.92	344	5.62	0.96	-0.30	872	0.77	-0.02
▪ Satisfaction with Growth Opportunities	530	5.07	1.18	344	5.15	1.20	-0.99	872	0.32	-0.07
Organizational Commitment	530	5.23	1.15	344	5.24	1.12	-0.01	872	0.99	0.00
Career Commitment	530	3.56	0.74	344	3.31	0.73	4.78	872	0.00	0.33

Note. d is Cohen's effect size. Most constructs were measured using a 5-point scale with a few exceptions. Climate for Opportunity was measured on a 6-point scale. Organizational Commitment and all of the Satisfaction constructs were measured on 7-point scales. Currently Being Mentored represents the percentage of the sample that indicated having a mentor at the time of the survey.

duced intentions to quit (Baruch-Feldman, Brondolo, Ben-Dayan, & Schwartz, 2002; Ducharme & Martin, 2000; Lee, 2004). There are two main types of coworker support: affective and instrumental. Affective support is a form of social support that coworkers offer by being sympathetic, listening to problems, and expressing care and concern. Instrumental support is more tangible helping behavior demonstrated by assisting with work responsibilities, switching schedules and other similar behaviors. Our results showed no differences in the amount of affective coworker support that men and women working in IT reported receiving. However, women reported receiving significantly more instrumental support from coworkers than men did.

Supervisors

Leader-Member Exchange (LMX) has been widely used to characterize the quality of supervisor-subordinate relationships on the basis of mutual respect, trust and loyalty (see Graen & Uhl-Bien, 1995 for a review). Although it can be assessed from both the supervisor and subordinate perspectives, research most commonly uses subordinates' reports of LMX (Gerstner & Day, 1997), as we do in this research. Research over the past 25 years has shown that LMX is positively related to job satisfaction, organizational commitment and performance (e.g., Gerstner & Day, 1997; Major, Kozlowski, Chao, & Gardner, 1995).

Table 2. Impact of supervisor and subordinate gender on supervisor-employee relationship

Employee Gender	Supervisor Gender	
	Men	Women
Men	3.39 (.92) n = 374	3.70 (.87) n = 154
Women	3.56 (.97) n = 175	3.58 (.89) n = 168

Note. Cells indicate means (SD) for LMX.

As shown in Table 1, there were no mean differences in the levels of LMX that men and women in IT reported. To explore the potential effects of gender dynamics on LMX, we examined the quality of supervisory relationships as a function of supervisor and subordinate gender. Results of a 2x2 ANOVA show gender of supervisor matters little for female IT employees, but matters considerably for male IT employees—the interaction yielded $F_{1,867} = 5.97$, $p = .02$, $\eta^2 = .01$. The quality of the supervisor-subordinate relationship is best for male IT employees when they have female supervisors. Mean differences are shown in Table 2.

Satisfaction and Commitment

Results show that overall, men and women working in IT are equally satisfied with their jobs. They are also equally satisfied with more specific aspects of their jobs, including supervision, pay, the social environment and opportunities for growth. Women, however, report statistically significant greater satisfaction with their job security than men.

Our findings indicate that men and women in IT are equally committed to their employing organizations. However, women reported significantly less commitment to a career in IT than men. This is not to say that women are less committed to working. Instead, they are less likely to view IT as their "life's work" than men. This gender difference has the largest effect size ($d = .33$) of any in our sample.

To further explore the gender difference, we conducted a hierarchical multiple regression analysis to ascertain whether or not other observed differences between men and women in our sample accounted for the career commitment gender difference. In step 1 of the regression, we included the demographic characteristics on which men and women differed (see Major & Germano, 2006), including relationship status, number of children, IT relatedness of educational degree, salary, organizational tenure, years worked in IT and hours worked per week. In step 2, we entered influence and climate opportunity since women reported less of both than men. In the final step of the hierarchical regression equation, we entered gender. Results shown in Table 3 indicate that IT-related degree, salary, organizational tenure, hours worked per week, influence and climate for opportunity are all significant predictors of career commitment. However, even after controlling for these variables, women's commitment to a career in IT is lower than men's.

FUTURE TRENDS

Overall, our results show more similarities than differences between men and women in IT. Women and men enjoy equally supportive workplace relationships (e.g., similar levels of LMX and affective coworker support), and in some instances, women report modestly greater support than men (e.g., instrumental coworker support). In supervisory roles, women are effective and are better able than men to establish high-quality relationships with male subordinates. Notably, female subordinates report equally effective relationships with both male and female supervisors. Nonetheless, women still face barriers to inclusion and opportunity in IT. In particular, women are less likely than men to believe that opportunities are fairly distributed without regard to race and gender. Although men and women report similar levels of belonging and participation, women feel that they have less workplace influence than men. In other words, women feel invited to participate but perceive that their input has less of an impact than men's input.

One of our most meaningful findings is the gender difference in commitment to an IT career; women report lower commitment than men. This difference in commitment is not due exclusively to less inclusion, less opportunity or other demographic differences. Interestingly, our results show that organizational tenure is inversely related to commitment to an IT career (see Table 3). Perhaps there

Table 3. Effects of gender on career commitment after controlling for demographic variables, influence, and climate for opportunity

Variables	β	T	R^2	?R^2
Step 1:			.09*	
Relationship Status	.05	1.327		
Number of Children	.05	1.323		
IT Degree	-.19	-5.364*		
Salary	-.11	-2.521*		
Organizational Tenure	-.11	-2.892*		
Years Worked in IT	.04	1.037		
Hours Worked per Week	.19	5.110*		
Step 2:			.18*	.09*
Influence	.15	3.849*		
Climate for Opportunity	.21	5.383*		
Step 3:				
Gender	-.09	-2.665*	.19*	.01*

*Note. N=762. Relationship Status coded: single (including divorced, separated and widowed) = 0 and married or living with partner = 1. IT Degree coded: holds IT related degree = 0 and holds non-IT related = 1. Gender coded: men = 0 and women = 1. Standardized regression weights are reported for the step in which variables were entered. *p < .05.*

are trade-offs between commitment to a particular organization and commitment to an IT career, especially for women. It may be that the longer a woman works for her employer, the more invested she becomes in that organization, regardless of whether her work continues to be IT related. Because reduced commitment to an IT career is likely a precursor to leaving the IT workforce, developing a more comprehensive understanding of the factors that predict career commitment is essential.

CONCLUSION

The underrepresentation of women in IT has been attributed to several factors, including long hours, little work-life balance and a workplace that is inhospitable to women (Lambeth, 1996; Panteli, Stack, & Ramsay, 1999), few opportunities for social interaction (Misic & Graf, 1999) and reluctance of male supervisors to coach and mentor women subordinates (Ragins, 2002). Our research findings suggest that these factors may exert a weaker influence on retention than once thought. IT workers in our sample did not report working exceptionally long hours (Major, Cardenas, Davis, Germano, & Mickey, 2004). Moreover, women reported support from coworkers and supervisors. In terms of inclusion, women in our sample reported belonging and participating, but they do not believe that their inclusion leads to influence. More work is needed to increase the influence of women in IT departments. See Major and Germano (2006) for a description of our intervention methodology.

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KEY TERMS

Affective Coworker Support: A form of social support that coworkers offer by being sympathetic, listening to problems, and expressing care and concern

Career Commitment: Describes one's attachment to one's profession or vocation

Climate for Opportunity: An individual's overall perception of the fairness of the organization in terms of the management processes used to allocate opportunities, including interpersonal treatment, and the distribution of opportunities in the organizational context (Hayes, Bartle & Major, 2002)

Inclusion: The extent to which employees feel that they are part of important work activities. Inclusion is comprised of three components: belongingness, participation and influence. Belongingness is the degree to which employees feel that their workgroup members accept them. Participation is the degree to which employees feel that the workgroup invites them to take part in group discussions and decisions. Influence is the extent to which employees feel their participation actually has an impact on decisions.

Instrumental Coworker Support: Tangible helping behavior offered by coworkers in response to specific needs; for example, assistance with work responsibilities and switching schedules.

Job Satisfaction: Represents the employee's emotional reaction to his or her job overall and to specific aspects of the job, including supervision, job security, pay, social environment and growth opportunities. It is possible to have different emotional responses to each aspect of one's job.

Leader-Member Exchange: Describes the perceived quality of the relationship between employees and their immediate supervisors in terms of mutual respect, trust and confidence. May be assessed as either a supervisor or a subordinate perception; the latter being more common. Relationships are typically described as either high- or low-quality exchanges.

Organizational Commitment: Describes an employee's loyalty and attachment to one's employing organization.

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Making Executive Mentoring Work in IT

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INTRODUCTION

Although it is a relatively young discipline, information technology has a lack of gender diversity that is similar to many older sciences. For example, the 33rd annual Taulbee survey of computer science graduates indicates only 20% of those enrolling in computer science doctoral programs are women, and only 16.8% of those receive PhDs; these rates have been the same for the last few years (Zweben & Aspray, 2004). Moreover, once women move into computing careers, they can have a difficult time moving up the career ladder. For example, women's advancement in academia has been disappointing: 19% of the computer science faculty in the United States are female, but only 8.6% of full professors and 12.3% of associate professors are women (Zweben & Aspray). Similar figures are reported for women in industry as they hit the glass ceiling (Morrison, White, & van Velsor, 1987), but women in some countries may be catching up. For example, "pay and prospects for women in IT are the best they have ever been" in the United Kingdom: They achieved higher pay increases than men across all sectors for the 8th year running, but are still behind (Mortleman, 2004).

Thus, there is still room for women at the top. According to Corporate Women Directors International (2004), "The glass ceiling in corporate directorships is solidly in place." Indeed, only 7.5% of Fortune Global 200 boards have three or more women serving on them. Similarly, a recent survey sponsored by the UK Department of Trade and Industry and Shell revealed that a third of the boards of British companies still have no females (Cranfield School of Management, 2004).

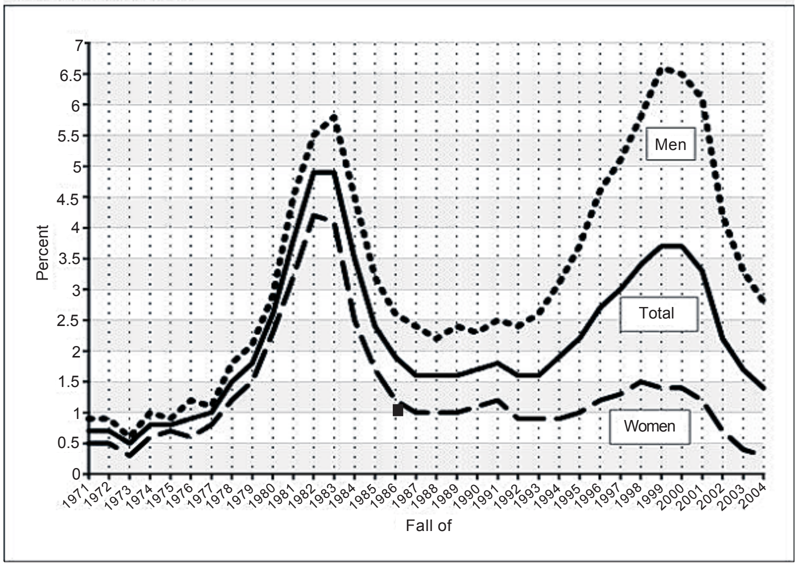
BACKGROUND

A 2000 study sponsored by the American Association of University Women (2000) notes that women comprise only 17% of the high-school students who take advanced-placement exams in computer science and only 28% of those with undergraduate degrees in computer science. Indeed, fewer women are expressing interest over time (see Figure 1). A major problem in attracting and keeping women and minorities in computer science (and other disciplines) is the lack of role models at all levels, and in particular at senior levels. In the early 1990s, we investigated what makes a good role model or mentor.[2]

MENTORING

Mentoring has long been associated with career advancement in business. Indeed, not only does "everyone who makes it 'have' a mentor" (Collins & Scott, 1978), but everyone needs a mentor. Recently, mentoring has become associated with efforts to increase the representation of underrepresented groups, such as women and minorities, in fields such as IT in which their presence at higher levels of such organizations has been notably absent. Professional and institutional calls for addressing the situation, whether responding to law or pressure, have led to creating projects and processes for changing the profile of top leaders and for enhancing the likelihood that women and minorities will advance. For example, the Computing Research Association's Committee on the Status of Women in Research has for 10 years conducted a distributed mentoring project:

Figure 1. Computer science listed as probable major among incoming freshmen



Source: HERI at UCLA

... to increase the number of women entering graduate studies in the fields of computer science and engineering. This highly selective program matches promising undergraduate women with a faculty mentor for a summer research experience at the faculty member's home institution. Students are directly involved in a research project and interact with graduate students and professors on a daily basis. This experience is invaluable for students…increasing their competitiveness as an applicant for graduate admissions and fellowships. (Committee on the Status of Women in Computing Research [CRA-W], 2006)

As organizations consider the underrepresentation problem, they almost invariably institute mentoring projects, pairing entry- and junior-level women and minorities with more senior-level members of the organization, most often the majority of whom are white and male. Despite the programs reported in the literature, and mentoring's ancient lineage, we know relatively little about the nature of such relationships and factors that contribute to its success. This situation is as true of traditional mentoring pairs (naturally occurring between junior and senior white males) as it is of relatively newly developed, arranged cross-gender or cross-race mentoring pairs (Mertz, Welch, & Henderson, 1988, 1990).

As part of a project sponsored by the National Science Foundation and the Association for Computing Machinery to institute and study mentoring for the career advancement of women and minorities in computer science in academia and industry, 15 pairs of mentors and protégés were studied over 18 months. All of the mentors and protégés agreed to participate, and their organizations were committed to the project and to the goal of advancing women and minorities in their organization.

Research Method

Approval was sought from highly placed members of the organizations' administrative or management chains. This buy-in was intended to maximize the likelihood of commitment to the project and to the mentoring process. Three industry organizations and two academic institutions agreed to participate in the project, to commit to mentoring women and minorities in their organizations, and to arrange for mentoring pairs of junior-level, promising women and minorities and senior-level persons. After an intensive workshop that examined the nature and intent of mentoring, the need for mentoring women and minorities, and the nature of the project, each pair set goals and objectives for the process and worked through anticipated problems and concerns together and with the workshop facilitators. Attitudinal surveys (toward mentoring and the need for mentoring women and minorities) and a preference instrument (Myers-Briggs Type Indicator) were administered to all participants before the start of the workshop. In addition, participants were interviewed individually, in depth, about their backgrounds, career aspirations, expectations, and concerns. During the project study period, each site was visited and each participant interviewed individually at least twice, the last interview occurring at the project's conclusion. These interviews explored events during the mentoring process, satisfaction with the relationship, problems or concerns, and generally how the relationship was faring. At the end, participants were asked to reflect on the entire process to assess its success (e.g., in terms of effectiveness) and their feelings. They also completed an attitudinal survey to complement the one completed before the workshop.

Findings

Of the 15 mentoring pairs, only 3, all in industry, were found to have been successful in terms of the criteria established for measuring the success of the process:

- Both members of the pair perceived the experience to be successful and reported that the experience had value.
- The experience involved actions and attitudes, particularly on the part of the mentor, specifically designed to help the protégé advance.
- The experience involved a professional relationship between mentor and protégé beyond simple advising or supervising, and beyond that which was required by the project. The mentor and protégé were involved in the enterprise together willingly, trusted one another, and felt their relationship would likely continue.

Two other pairs were partially successful (met two of the three criteria), two pairs were unsuccessful (met none of the criteria and indeed were dismal failures), and the remaining pairs were neither successful nor unsuccessful. They met at best one criterion, but were universally characterized by dissatisfaction or disappointment. For detailed information about the project, study, and its findings, see Pfleeger and Mertz (1994, 1995).

This article addresses what was learned about mentoring for career advancement from the relationships studied: what characterized successful mentoring relationships, what differentiated them from less successful and unsuccessful relationships, and what these findings suggest for implementing similar programs. The authors recognize that the small number of pairs studied limits the generalizability of the findings and lessons learned. Nevertheless, the depth of study of each pair warrants their acknowledgement and potential value.

What Characterized Successful Pairs?

First, they met regularly. There was no particular schedule; they met without having been prompted to meet. Beyond meeting, each protégé felt comfortable calling the mentor to arrange a meeting; this access represented a relationship another similarly placed person might not have had. Indeed, all protégés in successful pairings felt they could (but did not) call the mentor at home if necessary.

In two of the three successful pairings, the mentoring meetings were facilitated because the mentor and protégé worked in the same organizational division or line, or had work-related reasons to get together. However, this condition was not a necessary one, as one pair had members who neither worked in the same organizational division or on related projects, nor were even interested in the same kind of work, except in the most general terms. In this case, the mentor's commitment to the project, to its broad purposes, and to doing well in whatever was undertaken may have been the driving force underlying the success of the pair. That is, the mentor's attitude mandated success, so the pairing was successful. In the other two cases, it was a lot easier for the pairs to interact without making extraordinary efforts.

Second, in each of the three successful cases, the relationship between the pairs was characterized by respect for one another. Each saw the other as competent and seriously committed to work and to excellence, to being successful in moving up in the organization, and to doing so because of competence and past successes. There was compatibility in the values held as well as in career goals, and shared values made the participants comfortable in talking with one another.

Third, the relationship was focused on the protégé and what was needed to be successful. Where the mentor and protégé performed similar work, the mentor often provided opportunities for the protégé to have additional responsibility, to gain visibility for work done, to be recommended for challenging projects, and to participate in activities or projects that would stretch, challenge, or grow the protégé. In one case, the mentor shared with the protégé a network of contacts garnered from years of working in the field and, where appropriate, took the protégé to meetings with those contacts.

In the pair whose participants did not work in the same divisional line, the mentor accessed information, shared knowledge and experience about the company and how things worked within it, spoke to the protégé's superiors about the protégé's progress, and opened doors for the protégé by virtue of the mentor's high position.

Fourth, the mentor and protégé became associated with one another in the minds of others; their relationship was known and noted within the organization. None of the three mentors had any problem with this perception. Indeed, they saw some benefit in this association. The protégés came to hold the status of fast-trackers: people who have been identified as having potential and who are being considered for future promotion. Protégés seen as fast-trackers were legitimized on the basis of their perceived potential, not (as in the case of others involved in the project) because they were women or minorities.

What Characterized Unsuccessful Pairs?

In pairs that were unsuccessful, the mentors and protégés did not share a common perspective about mentoring or about what should go on in the name of mentoring. While the protégés were concerned about getting ahead, one mentor had severe reservations about the need to mentor and especially to mentor women or minorities. Furthermore, this mentor saw the role as listening to problems the protégé might bring and telling the protégé what to do. Another, while keenly aware of the value of mentoring, saw the role as helping the junior person to understand how to fit in (fitting in being the path to eventual success), not necessarily how to get ahead. Moreover, all but the successful pairs, particularly the unsuccessful pairs, did not seem to share the same values or views of the world, which contributed to problems in the relationships.

The unsuccessful pairs had difficulties in communicating with one another and found, over time, that these difficulties increased. In one case, the mentor felt that the protégé did not approach the mentor with problems, resented it, and concluded that no further interaction was required. In part, this mentor felt that the protégé had not fulfilled the responsibilities of a protégé. Interestingly enough, the protégé did not trust the mentor and did not believe one should go to a mentor with problems.

These two unsuccessful pairings were quite different from one another but were equally disastrous. In one case, the mentor did not respect the protégé; in the other, the protégé did not respect the mentor. Nothing about their interactions changed these perceptions. Indeed, although neither party of either pairing said so directly, they appeared to have less respect for one another after the experience than before, and the mentors' attitudes toward the project and toward mentoring were more negative after the experience. Their interactions disintegrated quickly, resulting eventually in a complete lack of communication between mentor and protégé. Neither pair engaged in any conversation about this sad state of interaction; the pairs just let the relationship die.

To greater or lesser degrees, the pairs that were neither successful nor unsuccessful shared some of the same characteristics as unsuccessful pairs. There was little clarity or consensus between mentor and protégé about the role of the mentor or the goals of the mentoring, despite identifying these clearly at the inception of the project. The participants in the pairing did not develop a comfortable rapport or find a common basis for interacting. This dissonance was exacerbated by situations in which there was no basis for their working together, or where the mentor did not necessarily see a need to increase the number of women and minorities in the field or company. Some of these mentors did not see why the protégé had been chosen to participate, had reservations about the competence of the protégé, or were uncertain about why the protégé had been assigned to them. In other words, the mentors had no initial commitment to the protégés and saw no reason to become committed to them. Several of these mentors explained that they were very busy with their own work and had no organizational accounting code to which to charge the time spent in mentoring. In general, the unsuccessful mentors perceived no organizational or personal benefit to be gained from mentoring.

TRENDS

While advancement was not a criterion for assessing the success of the mentoring experience, given that it was the focus of the project, one might reasonably ask what happened to the protégés? Was there any relationship between involvement in the project or in a successful mentoring pair and promotion or recognition within the organization?

Of the 10 industry protégés, 5 received promotions after the mentoring project's inception, and 2 received salary increases (one in conjunction with a promotion). One protégé was a finalist for a coveted department-head position. Although the protégé was not ultimately chosen, having been a finalist was considered a great coup. Two protégés were accepted in a highly competitive, company-sponsored program that provided paid time off to pursue an advanced degree (one in conjunction with a promotion). In the academic setting, where achieving tenure and promotion are the marks of advancement, the study did not proceed long enough to learn the fate of the protégés.

It is not clear to what extent any changes in the status or position of the protégés can be attributed to the mentoring project or anything done in its name. The changes might have occurred if the project had never existed. However, it is interesting to note that of the three pairs that were successful, two protégés were promoted and the third got a level increase and was a finalist for promotion.

CONCLUSION

Although the limited number of participants lends tentativeness to our conclusions, several clear observations can be made. First, the success of mentoring programs depends on the degree of commitment of the participants and of their organizations. It is not enough for an organization to profess interest in and to value gender diversity by establishing a mentoring program. Mentors must be convinced of the protégé's excellence and be willing to invest time and honesty in the mentoring relationship. Likewise, the protégé must be able to trust the mentor to a higher degree than in an ordinary professional relationship.

At the same time, the organization must demonstrate formally that it values the protégés, the mentors, and the mentoring program itself. Mentoring cannot work as an afterthought. The most successful pairs brought energy to their relationship and made time for it, sanctioned by their home organizations. Even when mentor and protégé did not work in the same division of the organization, organizational and personal commitment overcame what otherwise would have been insurmountable obstacles.

Third, the careful selection of pairs is essential. It is not enough to identify good mentors and good protégés, and it is not necessary to match gender or racial characteristics. In the right pairing, each member must share an appreciation of what is important to their organization and to their profession; they must have a similar worldview. For this reason, preparation and training are needed to help the participants get to know each other, to assist them in understanding the nature and degree of the commitments they are about to make, and to explain their roles and responsibilities.

In particular, the participants must have a strong commitment to advancing women and minorities and an understanding that advancement does not just happen. The mentors should believe that senior people must invest in junior people as part of their professional responsibilities, regardless of issues of underrepresentation. That is, the mentors and their organizations must believe that the best people are encouraged and developed by investing in and nurturing them.

Our mentoring program was designed to enable different pairs to communicate if problems arose. However, once the mentoring pairs were established, there seemed to be little interpair communication. Indeed, the presence of another pair in the same organization did not make a difference; if a pair did not form a successful relationship, the other pair was not consulted for help or advice. Thus, a central mentoring advice service may be useful in helping organizations get started and in assisting pairs to overcome problems that arise.

Finally, mentoring is very difficult. More pairs failed than succeeded. Different organizations used different techniques for choosing participants and assigning pairs. Where the basis for selection and pairing was not achievement and respect, the mentoring did not work. Thus, those interested in establishing mentoring programs must consider two key questions before starting any mentoring: What does excellence mean in an organization, and what engenders respect in the organization and in computing at large? The answers to these questions depend on the organizational context and values. Therefore, different organizations are likely to have different mentoring programs. The common thread is an appreciation of gender and racial diversity as well as a desire for excellence. Just because mentoring is hard does not mean that it is not valuable. In fact, it means the reverse: that organizations with successful mentoring programs should be congratulated for their commitment and viewed as role models for the rest of the profession.

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KEY TERMS

Career Ladder: The hierarchy of job categories possible for an employee.

Fast-Tracker: Person identified as having potential and considered for rapid promotion.

Glass Ceiling: Obstacles that prevent an employee from moving up the career ladder beyond a certain point.

Mentor: Senior person who provides advice and counsel to a less experienced junior person.

Pair: A designated relationship between a mentor and a protégé.

Protégé: Junior person who is identified by a mentor as deserving of advice and counsel.

Role Model: Person whose actions and accomplishments provide goals for others.

Underrepresented Group: Group disproportionately underrepresented in a particular profession or activity compared with its availability.

ENDNOTE

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[2] Additional information about mentoring can be found in the following resources:

Boards still lack female faces. (2004, December 7). *Accountancy Age.* Retrieved from http://www.accountancyage.com/news/1138886

Mertz, N. T., Welch, O. M., & Henderson, J. (1988). Mentoring for top management: How sex differences affect the selection process. *International Journal of Mentoring, 2*(1), 34-39.

Making of a Homogeneous IT Work Environment

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INTRODUCTION

What is the responsibility of the information technology (IT) industry in addressing gender issues? Exploring recruitment and retention issues that exist for women are crucial for increasing the capacity and diversity of the IT profession.

An understanding of the underlying causes of gender under representation in the IT profession is needed to develop effective workplace human resource strategies to attract and retain more of this underrepresented group. Unfortunately, while there is a documented need for a deeper understanding of the imbalance in this field, there is a lack of adequate data, methods and theory to provide a basis for explanation and prediction. Despite numerous efforts to recruit and retain women into both educational programs in IT and the IT workforce, these efforts have largely proved unsuccessful.

Women remain acutely underrepresented at the higher-paying professional and managerial levels (National Science Foundation, 2000; National Action Council for Minorities in Engineering, 2001-2002; Annenberg Public Policy Center, 2001; ITAA, 2003; Geewax, 2000; Spender, 1997). While women now represent a significant proportion of the labor force, they continue to be underrepresented in the IT workforce. Women have made few gains in employment numbers in the sector between 1996 and 2002. The Information Technology Association of America (ITAA) (2003) reported that the percentage of women in the overall IT workforce actually dropped from 41% to 34.9%. The underrepresentation of women in the IT workforce can be attributed to a "pipeline" issue. Women earn significantly fewer undergraduate degrees in computer science and engineering than their representation in the United States (U.S.) population. (Camp, 1997; Freeman & Aspray, 1999; U.S. Department of Education, National Center for Education Statistics, 2002).

BACKGROUND

Theoretical Perspective

The theoretical standpoint from which IT recruitment has been viewed in this article is one encompassing the social construction of gender in the IT-enabled workplace. Many of the processes that take place within organizations on a daily basis are imbued with gender attitudes and behaviors, and have strong implications for power, exploitation and control in the workplace. Gender can be seen as a set of patterned, socially produced differences between male and female, which usually involve the subordination of women, concretely or symbolically (Acker, 1992, 1998, 1999). The social construction of gender in the workplace perspective posits the development of and maintenance of a masculinized IT culture that systematically excludes women from IT work and all educational and professional steps leading up to IT work (Trauth, 2002; von Hellens, 2001; Tapia, 2002). This view attributes the problem to the construction of IT as a "man's world." This perspective, although recognizing that there are no universally male or female cultural traits, emphasizes that within the IT workplace certain social characteristics are gathered together in a unit that has come to be seen as "male" and the excluded traits as "female." Female IT workers are faced with two choices: to masculinize themselves and "fit in" or to challenge the cultural system and attempt to feminize the workplace (Cockburn, 1983, 1988; Cockburn & Ormrod, 1993; Wajcman, 1991; Adam, Emms, Green & Owen, 1994; Balka & Smith, 2000; Eriksson, Kitchenham & Tijdens, 1991; Hacker, 1981, 1989, 1990; Hovenden, Robinson, & Davis, 1995; Murray, 1993; Glastonbury, 1992; Lovegrove & Segal, 1991; Spender, 1995; Star, 1995; Webster, 1996; Woodfield, 2000).

Three Case Studies

Three IT companies who fit the description of a dot-com were examined at various points during their life cycle: *Headsup.com*, *Contentman.com* and *Ebiz.com*. To read more about these studies please see Tapia (2003, 2004). Briefly, the three companies were overwhelmingly male (82%, aggregate data). For example, after 1 year of existence, Headsup.com had 80 employees, 19 of whom were female. After 18 months, 30 employees left, including 15 out of the 19 women. After 23 months, the company had 20 employees, none of which were female. After 24 months, the company officially folded.

Gendered Recruitment

During the era known as the dot-com bubble, how successful was the IT industry in terms of recruiting and retaining women? What lasting effects can we see from the dot-com bubble's social changes on women's role in the future of the IT industry (see Tapia, 2003, 2004)? The dot-com era can be characterized as a time in which the IT industry was facing an acute shortage of employees, and yet, as the analysis shows, chose to create a culture that made it very difficult for female employees to be hired, trained and retained. I argue that in a few small start-up firms, the organizational culture created during this era made it nearly impossible for female employees to be recruited and retained. These cultures may have satisfied the immediate needs of the small start-up IT firm but were disastrous for traditional organizational measures that protected, recruited and retained women in the workforce, and that make the IT workplace hospitable to a variety of people, including women.

The dot-com era and its accompanying get-rich-quick mentality led to unconventional hiring practices, which led to the hiring of homogeneous populations, excluding women, people of color and older professionals. The essential problem with this is that IT has become associated with many material and immaterial benefits in society. This method of hiring systematically selected individuals of one race, gender, age, background, culture and class granted those benefits to a select few.

During this time, technical professionals believed they were capable of starting and managing their own business with no training, no business or managerial skills and no professional human resources help. This led to a lack of protective organizational norms and values. This opened the door to the creation of a hostile work environment. Protective organizations, such as a professional human resources staff, were seen as unnecessary fat in a lean, agile, fast-moving organization. The prevailing mentality fostered a short-timer culture in which anything was acceptable, since most employees would be gone in a matter of months. The rules and policies that would have protected women and minorities from the creation of a hostile work environment were seen as slowing down the process.

According to case data, all three companies used three recruitment strategies: online employment listings (such as Monster.com), personal references and recruitment parties. The most successful method of hiring the most employees was by far recruitment parties. However, the employees who were hired through personal contacts (i.e., friends of the owners) were the most long-lived at each company. The initial growth spurt for each company was accomplished via personal references. For example, during this growth phase, Headsup.com grew from 5 to 20 employees, all male. When asked, the additional 15 employees stated they were friends of the original five. They had known them at college, or in a past job or through a friend of a friend. For Contentman.com, the original 20 employees were very homogeneous. They were all computer programmers, all male, all in their mid to late 20s, and they devoted almost all of their time to work activities. Their time had no competition from external forces, such as families, pets, girlfriends or hobbies.[1]

Anticipating that they needed to grow fast, each company developed the second method of hiring: the college tour recruitment party. I argue that the development of this recruitment party was an extension of the first effort to hire more individuals who were just like themselves, but on a larger scale without the personal ties. The first phase of the recruitment party was to send invitations to universities' management information systems (MIS), computer science (CS) and information systems (IS) departments and computer labs on campus. This is significant, because the arenas in which these companies were seeking new employees (MIS, CS, IS) were already strongly male dominated.

At these parties, the owners attempted to convey financial success and a fun, youthful, relaxed working environment. They provided very expensive, sophisticated food and drinks. At the same time, they also provided video gaming systems and wall-projection units for the candidates' entertainment. The owners/managers would circulate among the invited candidates, chatting and what they call "geeking," discussing technical issues in a fun, lively banter, with a one-up-man-ship style, seeking which person knew the most obscure technical facts. They ate, they chatted, they drank and they played one-on-one fighting games like "Soul Caliber" against one another for hours. No formal interviews were ever held, no formal questions about the applicants' technical expertise were ever asked, no credentials or references were ever examined or checked; yet the majority of new employees were hired through these recruitment parties. It became apparent that these organizations used these recruitment parties as a cultural sifter, sifting out those that were the closest match culturally to the owners/managers and original formative employees. To be hired by one of these companies, the candidate must first pass a series of "tests" that, while intentional or not, weeded out almost all women and people of color. The result was a very homogenous workforce.

Eventually, each company hired a few female computer programmers through recruitment parties, and several more women were hired locally through personal contacts. The facts are that the owners/managers of these three companies did not hire a significant number of female employees, the female employees that were hired left (or were laid off) before the business closed, and these departures may point to the existence of a hostile work environment that drove them out (see Tapia 2003, 2004 for more detains on this hostile work environment). Another possible explanation is that the women who left saw reality a bit more clearly than the men that stayed. They saw the layoffs and the beginnings of organizational failure and got out before the doors were closed for good. In the case of Contentman.com, the company's first closure was dramatic in that the doors were closed to all remaining employees before the start of work. The employees were left at the door without paychecks owed them, their personal items, their retirement investments, their health benefits and any sort of notice or explanation.

CONCLUSION

The administration of these dot-com era companies intended to enter the market with a single product, make as much money as possible—as quickly as possible—and get out of the market just as quickly with their millions. They had no intention of "changing the system," nor any concerns about quality or diversity. These owners expressed a concern about external pressure that they felt was exerted upon them by a high-speed, high-change industry with millions of dollars to win or lose.

This need for speed, agility, incredible outputs of time and effort led owners/managers to hire employees who were a cultural match to themselves. They hired a homogenous workforce who were highly technically competent, likely to put in long hours, required little training, socially unfettered and in all ways flexible. Their most successful hiring efforts were aimed at university centers filled with young men just like themselves. Their office cultures rewarded social behaviors that fostered competition, extreme efforts and the degradation of the weak (and feminine).

These categories, however, were not exclusively tied to biological sex; there were indeed "masculinized" women in the form of a few female programmers and "feminized" males in the form of the servile assistant to the system administrator. These categories were powerful enough to associate a higher status with and create an opportunity structure for those employees who exhibited masculine behaviors (as defined by these organizations). This presented a clear dilemma for women who may have sought entrance into the IT workforce of the dot-com era, what had come to be known as a highly lucrative industry. Given that much of the hiring was done through recruitment parties in principally male environments and through male-to-male word of mouth, women were excluded from the hiring process. If they were hired, against all odds, they were forced to adopt "masculinized" cultural behaviors to fit in. Those that didn't were seen as outside the system (quite literally in many cases) and were treated as outsiders.

The homogeneity of IT departments increases the likelihood of the development of unacceptable anti-social behavior. Diversity of skill sets is important for the economic success of businesses in the industry. In addition, homogeneous IT worker populations lead to a lack of creativity, stagnation and potential business failure (Florida, 2002). Real intellectual and social diversity should foster constructive dissent. Homogeneous IT departments can also breed groupthink (Janus, 1972), in which the group can make bad or irrational decisions as each member attempts to conform his or her opinions to what they believe to be the consensus of the group.

FUTURE TRENDS

The future of recruiting women into IT work is unclear. Times are changing for the IT employee. Since the bursting of the dot-com bubble, the market has been slowly moving from a *sellers' market* to a *buyers' market,* in which the hiring organization has the upper hand in the employment relationship. Competition has increased for IT applicants for the first time in several years.

Prior to the bursting of the dot-com bubble, employers hired IT staff based on the potential of the new hires, rather than the degree, experience or credentials the hire already possessed. According to the ITAA (2004), at the turn of the century, hiring IT managers tended to play down the importance of a college degree, letting practical experience replace more formal education and training credentials.

The crisis in the supply of IT workers has not just happened as predicted. Although supply has remained low for several reasons, such as the massive retirement of technical baby boomers and the steady drop-off of students graduating with a degree in a computer-related field, demand has also dropped. In addition, since 2000, approximately 100,000 computer software and services jobs have moved offshore, including both domestic jobs eliminated and new jobs created overseas (ITAA, 2004).

Due to increased competition, the threshold to enter a career in IT has been low in the past, but is rising. Like other occupational groupings, employees in the IT sector are becoming increasingly professionalized. This professionalization raises the bar for entry into the field by increasing the value of formally obtained education, training and certifications.

This is a double-edged sword for women seeking to enter the IT field. On the positive side, a woman in possession of a degree or certification in IT is more likely to be on equal footing with all other candidates possessing similar skill markers. Culture matters less in a tight market, so highly skilled women are more likely to be recruited. Employers are also seeking to hire employees for longer tenures, therefore investing more in terms of training into the employee and in work-family friendly policies, increasing the likelihood of retention. On the negative side, since competition is growing among IT employees and potential recruits, those without formal IT training, degrees and certifications will have a much harder time entering the field. If the trend in the pipeline continues and women enter IT education programs in fewer and fewer numbers, this plus increased professionalization and competition will effectively weed out most women from the IT workforce.

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KEY TERMS

Dot-Com Bubble: The disproportionate market hysteria created under the premise of the endless investment possibilities of the Internet and services related with it.

Geeking: It is to sit online and read mail, news, chat and consult other sources of information primarily related with computers and technology.

Groupthink: Groupthink is a term coined by psychologist Irving Janis in 1972 to describe a process by which a group can make bad or irrational decisions. In a groupthink situation, each member of the group attempts to conform his or her opinions to what they believe to be the consensus of the group.

Hostile Work Environment: A hostile work environment exists in a work place when an employee experiences harassment and fears going to work because of the offensive, intimidating or oppressive atmosphere generated by coworker(s).

Human Resources: It is the part of management that deals with the attraction, retention and development of employees.

Sexual Harassment: It is unwelcome sexual advances, requests for sexual favors and other verbal or physical conduct of a sexual nature that take place in a work or work-related environment.

Short Timer Culture: It is a expression used to describe the small interval of time that nowdays the customs and traditions take to appear and fade away.

Start-Up Firm: It is a company that fits in one of the following criteria: Time in business does not exceed 4 years, no public offering, annual sales do not exceed $1,000,000, or a minimum of one full-time employee and no more than 12.

Work Life Gap: Differences among amount/quality of time that a person dedicated to activities related with the work environment and his or her personal life.

Zero Drag Employee: It is a term for the employee who is available at a moment's notice. The ideal zero-drag employee is young, unmarried, and childless with no responsibilities and an eagerness to do well.

ENDNOTE

[1] This is known as zero drag (Perlow, 1998; Kunda, 1999).

Managerial Careers, Gender, and Information Technology Field

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INTRODUCTION

Careers are organizational and institutional, and they have know-how-based contexts. Managerial careers from a gender perspective, gendered "blind spots" in organizations and the invisibility of women in management have been an object of study since the 1970s. Gender is a part of socially constructed individual identity. Gendered identities in organizations are defined and redefined in relationships as people become socially constructed through work groups, teams and interactions. Because of this social construction, femininity and masculinity grow into human behavior and outlook. Understanding gender as an activity and a term in the making (Calás & Smircich, 1996), it is a constitution of an activity, even when institutions appear to see woman and man as a stable distinction (Korvajärvi, 1998). Beyond work-life and organizations, there are multiple institutional and gendered structures. The information technology (IT) industry and companies are also an institutional construction with gendered dimensions, and they also participate on the creation of femininity and masculinity.

Career can be seen as a conceptual artefact that reflects a culture and rhetorical context in its use. It is a kind of window to a network of values, institutions and functions, where actual careers are made. Usually, the formal organization is based on neutrality and equality, but a closer look reveals the deeper social structures that make it different to women and men. There is a concept of an abstract and neutral worker, and this worker is supposed to be highly competent, work-oriented and available, committed to work-life without any knit to private life. These characteristics support a good career climb in an organizational hierarchy, and many of these characteristics better suit men than women (Metcalfe & Altman, 2001). For instance, home responsibilities make often working hours less flexible for women than men. The notion of an essential person with no gender characteristics does not recognize these issues, whereas taking gender as a research topic shows that work-life as a context differs between women and men.

BACKGROUND

Managerial Positions within the IT Industry

Organizational structures, including managerial positions, are gendered by nature. Overall, there is a high degree of vertical segregation, which means that there are few women in managerial positions compared to men (Acker, 1992). According to the United Nations' *World's Women 2000* report, women's share of the administrative and managerial labor force is less than 30% in all regions of the world. This is true also in Nordic countries, where the participation of women in work life is almost 70% and has a long tradition. Women also hold only 1% to 5% of all the top executive positions (Wirth, 2001), and the numbers seem to change very slowly. In the European Union countries, women's share has barely changed since the early 1990s, and has remained at a less than 5% level (Davidson & Burke, 2000). This division of managerial top positions is called glass-ceiling phenomena, and it exists world wide (Powell, 1999): "The higher the managerial position the fewer the women." As a result of this, women and the highest economic power become separated.

Taking a closer look at the numbers, the least amount of women in top positions are found in male dominated areas, such as heavy industry and construction business, where the amount of female leaders is less than 10%. IT is also a male-dominated field. There are few female directors in an organization that employs mostly men (Kauppinen & Aaltio-

Marjosola, 2003). The number of female managers has increased slowly. In many fields, like IT, it is still low (Ahuja, 2002). Women's and men's work in organizations also differ from each other by nature; that means women and men end up doing different kinds of work horizontally.

Current statistics indicate that women account for about 25% of technology workers in the European workforce and about 20% of those in the United States' (U.S.), and that there looks to be a polarization in the type of work women and men do. The majority of women are employed in routine and specialist work, like clerks, while men are engaged in analytical and managerial activities. In the studies, overall 10% of males and only 3% of females within IT had achieved senior managerial positions (Ahuja, 2002). Salary gaps for women and glass-ceiling perceptions are reported as well in this research. Despite that the IT profession has grown in recent years, there remains a gender imbalance and, in some cases, even evidence of a decline in female workforce numbers (Ahuja, 2002).

Managers and leaders have identities that become constructed within special circumstances, and IT constitutes a particular background for identities to grow in. As stated by Davis (1995), organizations and their activities are cultural constructs arising from the masculine vision of the world, and IT's close connections to the male-dominated technology field and its high numbers in male participation makes its connection to masculinity evident. The glass ceiling in the IT field might even be stronger that in others, because there is evidence that women there tend to be stereotyped as staff, the ones who don't take risks, rather than "line" people; whereas men are the innovators and designers (D'Agnostico, 2003; Russell, 2004). This results on men's career outcomes including higher managerial positions.

The segregation of work is based on the classical stereotypes of women's and men's behavior and orientations. Men are oriented towards technical and industrial work, whereas women are engaged in occupations where one needs caring ability and social integration, such as teachers and nurses. Ideals for men's and women's work differ from each other and carry stereotypes (Aaltio, 2002). Women and men are easily valued differently because of their gender. In society, there are different places for women and men, and this holds both in families and in work organizations. Men historically relate to the public and women to the private spheres of life (Acker, 1992). By extending their roles and breaking into public institutions, women challenge the prevalent male ideals and bring private issues into public and institutional spheres. Career opportunities mean different things for men and women and, therefore, challenge them differently.

It is also notable that the relationship between gender identity and participation in the IT profession is not the same for all women, nor is it based on monolithic values that are the same for all women. Each individual woman experiences societal influences differently and brings her personality and characteristics into the field (Trauth, 2002), even if women's institutional backgrounds are similar.

WOMEN'S CAREERS WITHIN THE IT FIELD

Discourses of Career: Interviews from IT Managers

In the study, five managers were interviewed, two of them women and three men. They all work in a large, successful IT industry company in Finland, are young or early middle-aged, and are labeled as high achievers with a promising future in the company. In the interviews, it was asked how they see their managerial career development up until now and in the future. The data gathered was narrative by nature, because a lot of space was given to open talk around the topics raised at the interview (Aaltio-Marjosola, 2002).

As one of the managers describes: "Professional development is my area, and I am globally responsible [for] this part of the business. The culture here in the company is, however, where I start from. In my close network, we have a team of 10 people, but globally, it is a big circle, of course." As seen in the citation, instead of manager-subordinate relationships, she emphasizes the close network and teamwork orientation. Another manager illustrates his job with no clear subordinate relationships: "I came here to coach a team with a few people and to coordinate things. This is more or less process management; I have to think first and then make things simple and concrete, communicate them to the others. I work closely with the head of the company in some projects, in addition. In fact, I do not see that there is a clear organization where I am a leader."

Further, one of the IT managers describes her job: "I am a personnel consult, even if I also take care of the unit's personnel management, and my work is multiple of things. For instance, I also do training and lecturing in our inner training seminars." In spite of the high organizational position, she sees her job to be consultative, including support of teams.

It is also typical to describe career development that includes multiple paths, work in many organizations and rapid movements during the career. One of the managers described his work: "I find that my career is more or less a bumpy road, not going upward all the time. I have started two times from a beginning in my job and found that you have to take your space in every new job no matter what is your position when you start. You have to find your fit to the values of the enterprise, feel they are near to yours, to get the right start." Still another manager describes his career development: "My job is changing. I will take care of the process development here, coordinate and harmonize things. I have to move as rapidly as the whole company does, this is the way it comes here. The number of my subordinates will be like 50 or 100 altogether, I am not quite sure how many they are, in fact."

Career, in the descriptions of these managers, is advancement of abilities, seeing oneself as an important and integral person in a certain close network, and giving good support for subordinates. None of the interviewed managers started their description of their work from the organizational ladder or other kind of embodiment of hierarchy. This shows the IT industry's development, being at the top of companies that themselves develop work practices and communication styles that break traditional ones with hierarchy and high formal authority. Much of the work is based on projects and close teamwork. Both men and women adapt into this if they seek to be successful in the company and get advancement.

Managerial Careers of Women within IT

Today's careers are based on a variety of choices; careers are "boundaryless" due to multiple routes and individual choices. To predict career development is more difficult than it used to be. Individuals' knowledge and skills give them good possibilities to move from one job to another, and organizations seldom serve for a life-time basis in a person's career development. Flexibility and adaptability of careers have increased, and diverse assignments are common instead of a clear and one-path kind of career development (Arnold, 2001; Storey, 2000). Work will become rich from difference and requires abilities and motivation typical for women, who have always combined many roles, private and public, and thus learned flexibility.

For instance, Ahuja (2002) suggests that there are barriers to female managers' careers within IT, and that their minor positioning in the IT industry is due to an "old boys" network. There is a large pool of qualified and experienced male professionals, whereas the pool of women is still few. This counts for a lack of female role models and mentors for the younger generations, and discriminatory practices remain. There is also evidence that women do not see IT as an attractive option, and even if they do, they are technically less equipped to come over. There are few managerial role models for women in IT industry companies, and women would benefit from career consulting.

Himanen (2001) argues that computer hackers will become heroes of the information society, and the heroes of IT are and will in the future be men, as seen in, for example, Silicon Valley, where there are very few women in higher-level positions. However, men also represent a variety rather than a unity. Taking the fluid notion of gender, we can see that masculinities are carried by organization cultures and are not unitary. In the changing work life, advancement also requires new skills and attitudes from men, not only for women as a unitary category.

Also, family-work contrast barriers were reported. A survey (Prencipe, 2001) outlined attitudes of IT women leaders, half of them in senior positions. The study showed a positive personal valuation of one's work, but also that balancing personal and professional life was still complex for most of them. Reported stress was due to working late, constant change and sometimes reported discrimination in a social environment consisting of mainly young, often male colleagues (Prencipe, 2001). When managerial career advancement starts from lower professional levels, factors like role stress tend to decrease job satisfaction, resulting in lower career outcomes of women (Igbaria & Chidambaram, 1997). In addition, at the institutional level, where changes are very slow, women and technology are still a combination that arouses suspicion.

FUTURE TRENDS AND NEEDS OF RESEARCH

Challenges of IT women managers' career development are in line with the results of earlier gender studies. In addition, the attractiveness of the company cultures for women mangers is also questionable, because of the cultural codes that might be gender-biased, repulsive and more favorable for men to follow. These cultural codes need to be studied and better understood.

As a part of high technology, IT has taken the world by storm and is changing the way businesses learn, as well as the nature and characteristics of work. The implementation of IT within and across organizations is reducing the importance of hierarchy and command-and-control authority systems that structure power within them. High technology changes the traditional managerial and communicational style from vertical to horizontal (Zeleny, 1990). In high technology-oriented industries, power is connected with expertise, which may break down the traditional hierarchy in an organization (e.g., Gunz, Evans, & Jalland, 2002). Research is needed on the special nature of work in IT companies, in order to understand which kind of management they really need, in terms of good results and higher well-being of the work force.

IT enterprises are themselves examples of "new" ways of management and doing work. It has been stated that the IT industry is in transition between the old sense of identity and the new one (Colwill & Townsend, 1999). As argued, the old culture was directed towards providing the answers, not at meeting the needs of the users. Working in intense networks is increasing and good communication skills are highly needed in the future. Gender-biased cultural expectations and gender stereotypes still work as a barrier for female managers' careers in IT. However, the changing nature of IT work and its prevalent practices make it open to diversity of expertise and values. Both women and men can benefit from these developments if the IT field itself learns gender-equality and tolerance.

The future's industries also compete to commit good expertise, and women are a resource. Multiple skills and their good management are needed, and new solutions to old problems will be searched. This also will advance women's managerial careers.

CONCLUSION

IT-field companies appreciate technology development. They have to learn understanding of social and cultural aspects that, however, are the true background for their development in the future. The field should attract both capable women and men. While there are a few managerial role models for women in the IT industry, women involved would benefit from career consulting and mentoring programs (Ahuja, 2002). The use of tele-work and e-leadership might also positively affect women in the industry, because they support combining family and work life (Avolio, Kahai, & Dodge, 2000; Beasley, Ewuuk, & Seubert, 2001). This kind of supportive activities may attract more women to the field and advance women's managerial careers. Organizational cultures that grow towards multiplicity of values and a variety of femininities and masculinities may be better work environments, especially for women but also for men in the future.

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KEY TERMS

Career: Consists of the sequential choices made by a person. It is a developmental process of professional identity and personality.

Culture: A human process of constructing shared meaning that goes on all the time and is based on human unique capacity for self- and other-consciousness.

Doing Gender: Concerned with the constitution of gender through interaction, and makes gender a consequence of an ongoing activity.

Gender: An integral part of socially constructed individual identity that constitutes and restructures a multitude of cultural and social phenomena.

Gender Bias: To generalize essential individual behavior without gender dimensions.

Gender Stereotypes: Refer to the traits and behaviors believed to occur with differential frequency in the two gender groups of women and men.

Glass Ceiling: A metaphor that describes the tendency of women get excluded from top management in organizations in spite of their occupation of middle-management positions.

Horizontal Gender Segregation: Refers to the structure of the workforce that tends to become separated into women's and men's work.

Organizational Culture: A collective construction of practices, meanings and expressions that can be seen developed in interaction within organizational social spheres.

Vertical Gender Segregation: Refers to the structure of organizations that position women on lower managerial levels compared to their male counterparts.

Matrix

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INTRODUCTION

1. Matrix = Womb.
2. *The Matrix is everywhere, it's all around us, here, even in this room. You can see it out your window, or on your television. You feel it when you go to work, or go to church or pay your taxes. It is the world that has been pulled over your eyes to blind you from the truth ... that you, like everyone else, was born into bondage ... kept inside a prison that you cannot smell, taste or touch. A prison for your mind. A Matrix.* (Wachowski & Wachowski, 1999)
3. *What is Matrix? Simply ... the "big Other," the virtual symbolic order, the network that structures reality for us.* (S. Zizek, 1999)

What is Matrix? In the past years, the notion of the Matrix has become dominant in figurations of cyberspace. It seems as if it is the most desirable, the most contemporary and fitting equation; however, its gendered etymology is rarely obvious. On the opposite, the gender of the matrix as a notion and term has been systematically negated in such disciplines as mathematics, engineering, film studies or psychoanalysis. It is necessary thus to explore and critique the Matrix as a most "fitting" metaphor in/for cyberspace that has conceived it (cyberspace) as a free and seamless space very much like the maternal body (Aristarkhova, 2002). The challenge today, therefore, is to reintroduce the maternal as one of embodied encounters with difference, to recover the sexual difference and gender in the notion of matrix with reference to cyberspace and information technologies that support it.

BACKGROUND

There is nothing new in this equation of matrix and cyberspace. This equation points out to a long history of use of maternal body as a source of "making sense" space as a foundational category (in addition to time). "Space" enables introduction of other notions, such as extension, arrangement, geography and body, among others. However, the origin of "space" itself is usually found in the maternal body, such as the case with "matrix" or its related notion: "chora." Once again, place for cyberspace has been found in a woman's body that has been misplaced, in this first and unique place (Irigaray, 1985), a house/home (Levinas, cited in Derrida, 1999; Derrida, 1997,1999) or container (Aristotle, cited in Irigaray, 1985). While some might celebrate this fact as effecting a "feminization of the cyberspace imaginary" and thus potentially empowering women, others caution us that it follows the Western tradition of depriving woman of her own place, treating cyberspace, in fact, like her (body): an instrument, as a dismembered tool waiting to provide a place *for* man; his cultural, technological and political aspirations (Irigaray, 1985; Plant, 1997). Whichever way one decides on how such imaginaries empower women, it is particularly noteworthy that this gendered nature of the notion of the matrix has been historically and discursively neutralized by constant references to its infinite openness and indifference to difference, sexual or otherwise in these new technologies (e.g., in films like *The Matrix*, and their postmodern formulations). Despite the occasional and even foundational references to the gendered nature of the matrix, little has been done to theoretically recover its positive attributes for rethinking cyberspace as such.

We can name at least three associations that currently operate between notions of cyberspace and the matrix, making it so appropriate for representations of cyberspace:

1. Both are seen as infinite and ever expanding, where expansion is itself their function (as in mathematics, where the initial matrix forms the

basis for serial and cumulative development; or in contemporary cybertheory and cyberpunk literature, where cyberspace is often assumed to be limitless and fully imaginary, to be filled with any desirable content).

2. They are supposed (and wanted?) as empty spaces, passively waiting to be filled and occupied—a fact that also lands to its being conceptualized as *virtual* vis-à-vis real. It is simply "out there," without having its own place, though providing a place for everything. As Doug Mann and Heidi Hochenedel define it, after Baudrillard (1994), "it is a desert of the real in which hyper real simulacra saturate and dominate human consciousness," it is "a map without territory" (Mann & Hochenedel, 2002). Being appropriated by phallocentric imaginary, matrix has become an empty space to be filled with any content, psychological, scientific, artistic or philosophical theorizations. It does not anymore belong to a body marked by sexual difference and gender.
3. Ultimately, both have been disembodied. Cyberspace has been invented as being nowhere and everywhere, which has no corporeal reference or geographical location. It is a place of ultimate escape, where we can explore our desires, anxieties and fears to become more stable, normal and healthier (in earlier social science literature, some assumed that exploring identity swapping in cyberspace would allow teenagers to overcome their fears of sexuality and "opposite sex").

These characteristics imply that the "matrixial," therefore, is indifferent to difference, that its infinite openness does not impose barriers on/to entry and participation. And also, participation is understood to be free and on equal terms. The matrix provides a sense of limits and spherical closure to limitless, borderless imaginary of cyberspace.

Thus, I argue there is a tension between the generative (as abstract) vs. maternal (as embodied) in definitions and representations of matrix as cyberspace. The appropriation of corporeal matrix and its relation to woman's body and subjectivity through scientific, philosophical and aesthetic reductions and abstractions in Western culture has been instrumental in producing cyberspace, fantasizing it as "self-reproducing," matrix-perfect mega-computer. In fact, these domestications of the notion of the matrix serve to disarticulate it from its relationship to embodied sexual difference, and are the matrixial as matricidal economies of cyberspace.

CONCLUSION

Thus, the issue at stake here is not so much a celebration of matrix as something that derives and undertsands woman's power as man's dependency on the maternal and the feminine, but rather, how the notion of the matrix serves as this mimicry of the maternal in cyberspace, as something that can be easily detached and performed without any references to sexual difference and gender. Therefore, a cyberfeminist critique of the certain recent appropriations of the notion of matrix is necessaryin order to find alternative (to matricidal) formulations and images of spaces generated with the advent of information technologies.

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KEY TERMS

Chora: A Greek philosophical term referring to that which gives place and enables spatial dimension. Chora might take a variety of meanings, including a container, an interval (like a zero), a variable (like an X) and a receptacle. It could also mean a nurse, a maternal space. Today, it is mostly used in philosophy and architectural theory to discuss the concept of "space" and how space comes about.

Cyberfeminism: A recent movement in art, literature and academia, cyberfeminism deals with the relation between gender and technology, or gender and machines. It covers a wide range of topics and practices, such as gaming, reproductive and biotechnologies, telecommunications, net communities and cyborg studies, among others.

Imaginaries: Introduced first in psychoanalytic theory, today the concept of imaginary is mostly used in sociology and other social sciences to refer to a system of values, laws and institutions "imagined" collectively within a certain social and cultural context in relation to a topic or issue. Here, it is used in plural to emphasize that there are varieties of imaginaries within a given context.

Matricidal: That which leads to the annihilation of the mother or of the maternal in cultural, social, economic, physical or political sense. Here, it refers to the substitution (as annihilation) of the maternal within studies of techno- and cyber-spaces by the concept of the matrix.

Mimicry: A biological concept, meaning a behavior of camouflage and self-concealment for the purpose of survival, has been adopted within psychoanalytic and feminist theory to refer to a desire for others through a response of fascination and an impulse to mimic.

Maturity Rather than Gender is Important for Study Success

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INTRODUCTION

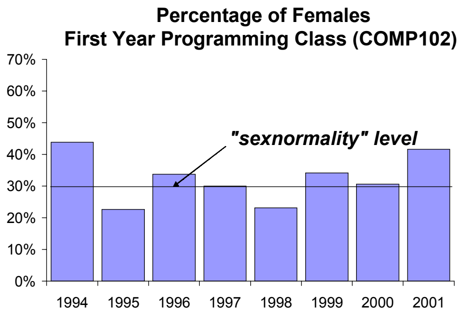
For a number of years there has been concern, particularly in the western world, about the low female participation and retention rates in computer science (Bernstein, 1994; Clarke & Chambers, 1989; Clarke & Teague, 1994; Durndell, 1991; Sturm & Moroh, 1994). Studies in New Zealand found similar trends (Brown, Andreae, Biddle, & Tempero, 1996; Ryba & Selby, 1995; Toynbee, 1993). More than ten years after these concerns were first raised, these problems largely still exist (Weston & Barker, 2004) although successful strategies are being reported (Cohoon, 2002; Fisher & Margolis, 2002; and other authors in *Women and Computing*).

To some extent at Lincoln University, New Zealand, the situation has always been different. Computing classes at all levels usually have a reasonable proportion of women (typically 25-40%). Furthermore, success in the first year programming class has been modeled for five cohorts and has been found to have no direct relationship to gender. The most consistent finding in these models is that older students are more likely to be successful than younger students. As well as summarizing the longitudinal study, key findings of interviews with some recent mature aged, female computing graduates are also included.

BACKGROUND

Lincoln University, with only 4,500 students, is by far the smallest of New Zealand's eight universities. It has a reputation for being "small and friendly". In addition to receiving compulsory course advice there is also considerable informal mentoring of undergraduate students. There are approximately equal numbers of male and female students and about 40% of students on campus are mature aged.

Figure 1. Female participation rate in COMP102 from 1994 to 2001



The computing degrees and diplomas offered are in applied computing, rather than computer science, and applied disciplines are known to appeal to women (Kossuth & Leger-Hornby, 2004). The introductory programming class (COMP102) has typically had about 120 students each year. This is a medium size class by New Zealand standards. It is usually at least 30% women (Figure 1) and can therefore be considered to be "sexnormal" (Byrne, 1993). Not all students studying COMP102 intend to major in applied computing and approximately 60% continue on to advanced level programming classes.

MODELING SUCCESS IN COMP102

For the five cohorts studied, the 120 or so students in COMP102, were surveyed to find their ages, genders, likely majors, expectations from this subject, and computing and educational backgrounds. Success in the subject as measured by final marks and grades, has been modeled using linear, logistic, and ordinal regression techniques (Agresti, 1990) for the 1994 (McLennan, Young, Johnson, & Clemes, 1999) and 1998 students (McLennan, Clemes, Young, & Kamikubo-Gould, 2000). A longitudinal study of the 1994 and 1998-2001 students, using artificial

Figure 2. Ordinal regression model for predicting the probability of passing COMP102 for 1994 students (adapted from McLennan et al., 1999)

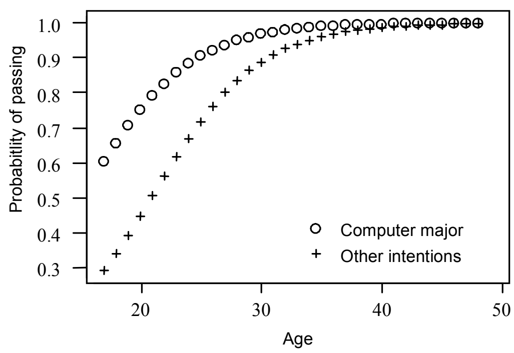
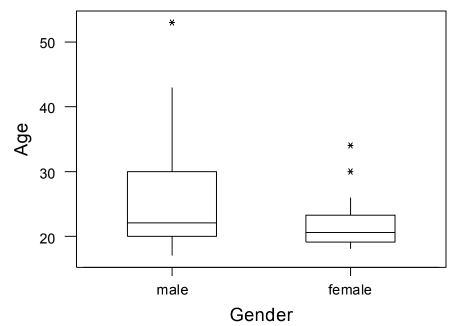


Figure 3. Box plots showing different age distributions for male and female students in 1998 (adapted from McLennan et al., 2000)



neural networks to model success, has also been completed (Li, Samarasinghe, & McLennan, 2002).

In the regression models the most significant factor contributing to success, was age, with older students more likely to pass than younger students. Not surprisingly, students with higher expectations and those intending to major in computing were also likely to do better. Figure 2 shows the probability of passing COMP102 for the 1994 students.

Given the prevailing view of the time, that computing was the domain of young males, it was surprising to also find in the 1994 study that gender had no direct bearing on likely success. This pleasing finding has been confirmed in all subsequent models. In the 1998 study there appeared to be a gender effect, because the average mark was 74% for men and 67% for females. This can largely be explained by the different age distributions for the sexes (Figure 3). A further factor was evidence that women had lower expectations and lower expectations were associated with lower marks.

Multi-layer perceptron artificial neural network models (Jain, Mao, & Mohiuddin, 1996) were used to model the final marks of students from 1994 and 1998-2001. Each year was modeled separately and for every year gender was not significant in predicting likely success. There were marked variations from year to year and age is the only consistently strong contributor for each model with older students always doing better. Viewed overall, a student's expectation of getting a good grade and having a strong computing background were also important. These results were not entirely consistent with the regression models where computing background was not a significant factor.

About one third of the students in the longitudinal study were of mature age. In the later years roughly 40% of the mature students were university graduates from other disciplines who were now studying for Graduate Diplomas in Applied Computing. It is not surprising that these highly motivated, older students, with a history of studying success did so well in general. However, this qualification did not exist prior to 1999, so it doesn't explain the success of older students in 1994 and 1998.

INTERVIEWS

In 2002, 17 mature-aged women who had recently graduated with majors in applied computing were interviewed to provide further insights on studying in a non-traditional area (McLennan, 2003). They ranged in age from 26 to 48 and had studied COMP102 between 1999 and 2001. Their median age when studying COMP102 was 36 and their average mark was 81% (compared with 22 and 61%, respectively, for the entire classes).

Questions were asked about their reasons for returning to studying and their study experiences. Almost all had returned to study for employment related reasons. Some wanted to change career direction and others, who wanted to re-enter the workforce, saw computing as providing challenge and financial security. In this sample, only five had completed degrees and of these women four had originally intended to major in other subjects. All of the others were already university graduates who were studying for graduate diplomas rather than degrees. Some of this latter group intended to pursue careers applying computing in their original discipline area. Invariably, they felt that studying applied computing was a more appropriate choice than computer science.

Getting started, both in COMP102 and higher level subjects, was sometimes an issue. For some, including a few university graduates, it was a completely new way of thinking. However, almost all of the women achieved higher grades in their computing subjects than they had expected. Some described the pleasure of studying with other mature students whereas others mentioned supportive staff and female role models. Group work was considered both a positive and a negative by these ex-students. Five women said without prompting that family or personal health problems had interfered with their studies.

Almost all had gone on to suitable employment although not all were in computing jobs. Many thought that their maturity was a positive factor when applying for jobs. None reported having current gender issues in their workplaces. The youngest said that she had previously encountered a male with a "pride factor". Pleasingly, several who worked as software engineers in strongly male dominated firms, reported that these were very "family friendly" workplaces.

CURRENT AND FUTURE TRENDS

The longitudinal study described above was discontinued in 2002. No attempts have been made to statistically model success in more recent classes largely because there has been a marked change in the educational and ethnic backgrounds with about 80% of COMP102 students being international students. Prior to 2002 only about 1/3 of the students in COMP102 were of international origin. One of the variables in the longitudinal study was whether or not the language of instruction at high school was English. It was not a significant factor for predicting success in any of the models.

Since 2002 the international students have typically been younger and less qualified than before. The majority have been of Chinese nationality and only a small proportion have studied at senior high school level in English speaking countries. Many have had difficulty with the level of English comprehension required to study COMP102. This has been reflected in lower average marks for the 2002 to 2004 classes compared with earlier years. However the average marks for males and females, while lower than previously, were still not significantly different from each other. It is also apparent that older students have continued to do well in COMP102.

The 2004 class (about 100 students) was the smallest for some years and it was only 24% female. The roll for 2005 has not been finalized, but the size and proportion of women will be similar to 2004. Some of the drop in class sizes for 2004 and 2005 can be explained by a decrease in Graduate Diploma in Applied Computing enrolments. It is hoped that a targeted advertising campaign will attract more women and graduate diploma students into COMP102 in the future.

CONCLUSION

Lincoln University, New Zealand, offers qualifications in applied computing rather than computer science. Both the introductory computer programming class and higher level computing classes required for this major usually have a reasonable proportion (25-40%) of female students. Success in the introductory class is not directly related to gender. Over a number of years it has been consistently found that older students do better than younger students. Not surprisingly, highly motivated students usually do better than less motivated students. This is variously reflected in the different models as either an intention to major in computing or by an expectation of obtaining a high grade. There are inconsistent results as to whether a good general knowledge of computing, prior to studying programming, is important.

A small group of mature, female, applied computing graduates have been interviewed. They had almost all chosen to study computing for career reasons. Most had achieved higher grades than they expected although many had trouble getting started and were grateful to be studying in a supportive environment. In general these women had found suitable positions on re-entering the workforce.

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KEY TERMS

Applied Computing: Study programmes in applied computing focus on evaluating and applying existing information technology techniques to solve real world problems. Subjects studied include systems analysis and design, programming, databases, hardware, operating systems, networking, end user computing and simulation as well as domain knowledge from areas of application.

Bachelor of Applied Computing: A three year, post high school, degree where students as well as completing a major in applied computing must also complete a minor in another discipline area.

Female Participation Rate: The percentage of students in a class who are female.

Female Retention Rate: The percentage of females in an introductory class who continue on to study at a higher level.

Graduate Diploma in Applied Computing: A one year course enabling graduates from other disciplines to study undergraduate subjects and complete a major in applied computing.

Mature Student: A mature student is defined as a person twenty five or older studying at tertiary level.

Sexnormal: There is a critical threshold in the proportion of female enrolments in a class or institution. Above this threshold, considered to be about 33%, female enrolments are considered to be sexnormal. Below this threshold female enrolments are considered to be untypical, abnormal or exceptional.

Mentoring Australian Girls in ICTs

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INTRODUCTION

In *Australia*, the participation rate for females in information and communication technology (ICT) courses in secondary, vocational. and higher *education* is significantly lower than that of males, and is decreasing (Thorp, 2004). In Queensland, Australia, only 20% (at most) of ICT *students* and employees are female, with the IT first preferences for tertiary admission down 22% for 2004 enrolments (Thorp, 2003). This downturn is in line with the trend in other Western countries and reflects the general lack of interest in ICT education amongst *adolescents*.

Recent Australian research confirms the importance of *role models* and *mentors* when adolescents are considering career options (Clayton, 2005). The importance of implementing sustainable strategies, such as *mentoring programs*, to rectify this imbalance cannot be understated. Jepson and Peri (2002) believe that mentoring programs should commence at middle and *high school*. Early mentoring programs are valuable as girls have fewer ICT role models and mentors in the classroom, industry and computer games (Carey, 2001). Mentors in these programs need to provide an accurate portrayal of the broad range of careers available in the ICT field (Klawe, 2002).

To date, a number of mentoring programs and intervention activities have been and continue to be undertaken in Queensland. This article presents three different mentoring programs the authors have been involved in and discusses the challenges involved in implementing these strategies. The first two programs discussed are for high school students and the third is for *university* students in ICT degree programs (von Hellens, Beekhuyzen, & Nielsen, 2005).

Adding to the complexity of this problem, funding to implement programs aimed at increasing female participation in ICTs may be difficult to justify due to the problems of measuring the effectiveness in achieving this goal. Australian researchers recognize this problem and are concerned about the absence of ongoing evaluation of programs to encourage girls into ICTs (Lang, 2003). While this chapter makes recommendations for implementing new strategies based on the experiences discussed, more work needs to be done on how to evaluate the efficacy of ongoing and future strategies.

BACKGROUND

Existing research on mentoring has focused mainly on mentoring programs within the workplace. According to this research mentoring schemes can help companies improve the gender balance of their staff and to develop a stable corporate culture (Limerick, Heywood, & Daws, 1994). According to mentoring expert Ann Rolfe-Flett (2002), a genuine outcome of mentoring programs in Australia is increased student retention. However, there is no clear Australian evidence connecting mentoring to improvements in recruitment of students to specific areas of study.

Mentoring programs in schools are aimed at achieving the fullest potential of each student in emotional health, academic achievement, interpersonal relationships and vocational knowledge through a positive relationship with at least one adult (MacCallum & Beltman, 1999). Although there is a diverse range of models of mentoring programs operating in Australian schools, there are no examples of students being mentored specifically on ICT career choices. The ICT mentoring programs discussed in this chapter are the first to address the lack of research in this area.

HIGH SCHOOL MENTORING

Mentoring Program 1

The first example of high school mentoring is the program for Year 11 students established in 2001; a collaboration between information and processing technology (IPT) teachers in a Brisbane high school and researchers at Griffith University (GU). The focus was specifically on female students although the program also included male students enrolled in the IPT class.

When selecting role models and mentors, care needs to be exercised in that females with a specific role in the industry are included and they can demonstrate attainable levels of achievement (Standley & Stroombergen, 2001). In keeping with this recommendation, 28 mentors were recruited, comprising ICT professionals, academics and recent graduates. Groups of 4 to 5 students were allocated a mentor who would assist the students with analysis and design of a programming assignment and provide general advice about the nature of ICT work and the skills needed to succeed as an ICT professional. Presentations of these assignments and past student work occurred during a concluding breakfast function. A research officer acted as a liaison between mentors and students and maintained contact with the schoolteachers.

Focus group interviews were conducted with the participating students to get in-depth comments about their mentoring experiences and changes in perceptions about ICT education and work. Feedback was also sought from teachers and mentors. At the end of the mentoring program, an online survey was used to collect demographic data and perceptions of ICT education and work from the Year 11 and 12 students. This data provided information on gender balance in the ICT course and the students' perceptions of ICT education.

Most mentors believed it was a worthwhile initiative and would be willing to support the program in the future. Students were eager to meet their mentors face-to-face and used the time to find out more about ICT study and where it can lead. This helped fit the IPT subject into the bigger picture and give it a real-life context. The mentors helped students with problem solving, teamwork and with their class assignment by sharing their expert knowledge on ICT project principles, risk management, and business systems.

The program provided more accessible role models for female students and provided a strong positive image to female students and corrected the widely held view that the ICT industry is intrinsically a male domain. Mentors became role models for female students, offering general information and advice about the industry and providing examples of the diversity of career paths within the industry and the variety of training options and skills that are considered valuable, all of which will positively promote careers in the ICT industry.

The main problem of the program was the lack of opportunity for students and mentors to meet before the program started. This would have provided a means of breaking the ice and perhaps facilitated communication and interaction during the program. Some groups made little or no effort to contact their mentors, while on the other hand, some mentors did not respond to student emails. These incidents indicated somewhat unexpected project management problems that could be corrected in future mentoring programs by more careful monitoring of communication between students and their mentors.

This program demonstrated that such a program could be a viable way to challenge female students' perceptions of ICT education, and to make ICT a more attractive career option. However, to confirm this finding, an IT mentoring program should also involve longitudinal studies on female students' perceptions of IT work and education. Such a study would help gain a better understanding of the way women help configure the institutional realm of ICT work and how this understanding can be passed on to school students.

The positive experience from this program helped Queensland Government's Office for Women and GU establish an ICT mentoring program for several high schools in 2004; the Get SET (Science Engineering and Technology) project discussed next in this article. Our experience suggests that mentoring, interactions with professional ICT organizations, and professional ICT women talking to females during their ICT education can improve the perceptions of ICT.

Mentoring Program 2

In 2002, funding was sought and obtained from the Office for Women and Education Queensland to provide a schools-based mentoring program to encourage female students to consider Science and ICT as career options. Fourteen mentors were recruited with Science, IT or Science and ICT degree experience.

Two very different schools were chosen to participate in this project. Students from one school (S1) come from a wide range of socio-economic, cultural, and ethnic backgrounds. S1 is a large school with a reputation for academic, performing arts and sporting success. One Year, a year 10 Science class of 26 students (23 female) was chosen to participate. Approximately 25 female year 10 ICT students were to participate, but logistical difficulties arose with this arrangement and year 11 and 12 students were substituted.

The second, smaller school (S2) is based in a low socio-economic area and is working hard initiating successful programs to assist with various social issues. Eleven high achieving female students were chosen to participate during interschool sport time.

Throughout the year, students from both schools were invited to a number of GU campuses to experience the university environment and facilities. Academics gave presentations about their research areas and the mentors demonstrated projects that they were working on. Industry visits for the students were organized with local companies. Teachers at S1 refused the industry visits citing that it was too much work and too difficult to release the students from normal classroom activities or that there was a lack of interest from the students. The teacher, students, and their mentor at S2 attended industry visits during school hours where they were able to talk with scientists and ICT professionals at work.

Students at both schools were involved in projects with the assistance of the mentors. The S1 Science class was divided into teams of four and worked on various research projects, including the creation and experimentation with lasers made using electronic kits. The students at S2 investigated the water quality of the Logan River, which abuts the school. The students conducted field experiments as well as more sophisticated laboratory experiments under the supervision of the laboratory staff, mentors and teacher. A Web page was also created to describe the project, the field trips and the experiment results. Mentors supported the students throughout the design and implementation of the Web site including interface design techniques and programming. In conjunction with classroom contact time, mentors and students at both schools were encouraged to communicate with email and instant messaging (IM) technologies. At the presentation night, students from both schools displayed their work to mentors, peers, parents, and other guests.

Throughout the year, all students working on the practical projects with the mentors responded very positively about Science and ICT and these successes highlight the need to integrate mentoring within the curriculum. It was also pleasing that many of the students who participated at S2 were eager to mentor other students in future years. This was an significant outcome as Margolis and Fisher (2002, p. 115) regognize that "… some of the best recruiters of girls are other girls."

A final critical issue is that even though the structure of the program may be correct, red tape may impede the project. To overcome this, there must be a project champion with status and power at the school who is willing to help surmount these difficulties.

UNIVERSITY MENTORING

The ICT chapter of the GU Alumni Association is now in its fourth year of running a successful mentoring program intended to guide and inform first year ICT students in their studies and their future careers. The mentoring program calls upon

Alumni members (ICT graduates) working in the ICT industry who are matched with first year ICT students. It encourages an environment for mentors to share their knowledge and experience in the industry by helping students with difficulties they experience with transition to tertiary education, planning their degree program, assessing career options, understanding the ICT industry, making contacts, and entering the workforce.

The pilot program was launched in 2002 with a $12,000 grant from the Queensland Government's Information Industries Bureau (IIB) and is supported by the Australian Computer Society. Feedback is used to continually improve the program which continued successfully in 2003, 2004, and 2005. Due to the expensive nature of running such programs, this program has been limited to 15 participants each year. Since 2003, the program has run with minimum monetary input and mostly on the goodwill of its participants and volunteer committee members. Each year a mentoring coordinator is appointed by the committee which has proven to be an integral role for the success of the program.

In addition to one-on-one mentoring, the ICT program involved mentor training, networking workshops, and social functions for the mentors and students, and was free of charge to all participants. The events held as part of the program do contribute somewhat to ongoing funding for the program. Events held during the program allowed students to come together early throughout the semester in an environment that encouraged academic and career achievement and allowed students to meet like-minded students as well as benefiting from interaction with the mentors.

The Opening Event for each year is a combination of a short formal session for training and briefing, and a relaxed session where mentees and mentors meet over food and drinks, enjoy the challenge of a trivia quiz, and spend time getting to know each other. A credible ICT industry professional presents a practical guide for people to become better at career networking in the aptly named "Art of Networking" mid-year event. It is believed that approximately 80% of ICT jobs in Australia are gained through word of mouth, thus strengthening the need for these essential skills. The Closing Events provide a final opportunity for participants to meet, reflect on the program, complete their evaluations and provide feedback.

Exploring Mobile Communication Technology in Mentoring

The continuing Alumni program offers participants the chance to integrate mobile communication technology into their mentoring. According to Gürer and Camp (2002), telementoring, can be used to enhance the mentoring process by supporting students while breaking down the barriers of distance and time. Since 2004, students have been part of telementoring experiments using mobile phones with Multimedia Messaging (MMS) features. Phones are given to mentor and mentee for a 10-day period. The exchange of MMS messages is emphasized, as visual information sharing enhances the ability to report on the mentor's and mentee's everyday working environment.

The results of preliminary studies in 2003/2004 are encouraging and suggest that mobile communication technology has possible value for mentoring programs. In increasing the frequency and density of communication between the participants, communication between mentor and mentee included direct information of work issues, but also descriptions of atmosphere and opinions related to mentors' duties. Both mentors and students reported increased frequency and flexibility in communication. This was highly valued because of the time constrains of both parties. Mentors also emphasized the easy access and speed of use of the technology, as sending a message with a mobile phone was regarded as more easy and flexible than e-mail, which took more time and was limited to the work situations with a computer. Also, participants felt that more frequent and often more informal interactions resulted in a close and relaxed relationship (Hakkila & Beekhuyzen, 2005).

FUTURE TRENDS

From the experience that the authors have gained in running school and university based mentoring programs, a number of recommendations can be made to assist new entrants establish successful mentoring programs for girls and women in ICT. Firstly, funding is an important issue. Mentoring programs can be expensive to set up and run, often with no economies of scale possible, as most programs require tailoring to suit individual need. Furthermore, the number of females in ICT careers and study continues to decline and pressure is often put on existing ICT students and professionals to participate in these programs. Adequate remuneration is also required for these often high-achieving mentors who may need to attend during working hours or take time from their busy study schedule. Secondly, it is also critical that the mentoring coordinator is successful in building and maintaining of relationships and networks with and between stakeholders to ensure continuing success. Moreover, evolving communication technologies such as email mobile phones and IM should be fully exploited in encouraging communication between students and mentors. Thirdly, school based mentoring programs also need to be integrated into the curriculum to ensure maximum reach and that programs have more impact and acceptance from the general school community. Finally, even though the structure of the program may be correct, red tape may impede the project. To overcome this, there must be an internal project champion with status and power who is willing to help surmount these difficulties.

CONCLUSION

This article discussed three Australian ICT mentoring projects and offered recommendations for future mentoring projects based on the authors' experiences. Recommendations include the need for: adequate and realistic funding to run these projects; a coordinator to build and maintain good relationships and networks; increasing use of evolving technologies for mentor/student communication; integration of mentoring projects into the school curriculum; and a project champion with power and status to overcome bureaucratic difficulties.

The programs outlined in this paper generally provided positive results in encouraging females to excel and be leaders in their ICT careers. However, long-term evaluation of all ICT mentoring projects is a neglected area of research. Considering the cost of these programs, it is essential to prove the benefit of these programs to justify and support the need for continuing funding of programs.

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KEY TERMS

Information Processing and Technology (IPT): A Queensland Studies Authority elective subject offered over four semesters as part senior secondary schooling. It aims to develop: student awareness and knowledge of IT; problem solving skills; communication skills, and critical thinking and analysis skills. It incorporates many areas including: social and ethical issues in IT; human-computer interaction; information systems; intelligent systems; and software and systems engineering.

Information Technology Field: The technical and people oriented area of information technology utilization in organizations and in society. Information technology education provides core technical skills for the analysis, design, and development of computer-based information and their subsequent implementation in organizations and the evaluation of such systems.

Instant Messaging (IM): A synchronous real-time method of communication over the Internet between two or more people. It is similar to a phone or conference call, except messages are text based. Contact details are swapped and added to individual contact lists.

Mentee: A person studying in high school or First-year University and interested in the area of IT. The mentee is involved in a mentoring program in which their role is to interact (with a view to getting help from) their mentor.

Mentor: A person working in IT and knows about the IT industry who is able to advise younger people about study options work opportunities in the IT industry. The mentor is involved in a mentoring program in which their role is to interact (with a view to helping) their mentee.

Mentoring: A process that allows a relationship to be created between a mentee and a mentor with a view to allowing the free flow of information leading to guidance, advice and encouragement.

Mentoring Program: A formalised and focused effort to bring mentors and mentees together in an encouraging, learning environment.

Multimedia Messaging Service: A mobile phone technology that allows people to communicate with any combination of images, videoclips, text, and audio through their mobile phone.

Secondary School: A stage of a youth's general schooling including Years 8 through 12 where students move between classrooms and are taught by a different teachers in various key learning areas. In junior secondary school, Years 8 to 10, most students follow similar syllabus although some choice is available in Year 9 and 10. Students may choose to continue into senior secondary school, Years 11 and 12, and choose six subjects offered by their school. Some secondary schools also now offer a range of accredited vocational subjects, traineeships, and apprenticeships.

Migration of IT Specialists and Gender

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INTRODUCTION

The purpose of this article is to analyze "after the shift," which occurred in the second half of the 20th century, from a goods-producing society to an information or knowledge society, as information technology (IT) began to be seen as a most important asset of contemporary nations. Bell argued in 1973 that in the new social order, knowledge and information would replace industrial production, and would become the "axial principle" of social organization (Bell, 1973). By the end of the 20th century, IT has also become a truly global phenomenon, involved with the reconfiguration of the labor market and human and material resources from all over the world. Gary Becker, the 1992 Nobel laureate in economics, pointed out that the United States' (U.S.) Silicon Valley currently employs 1 million people, of whom 40% have at least a bachelor's degree and more than one-third are foreign-born.

In the new information economy, special importance is assigned to IT researchers and developers, who belong to the global group of "knowledge workers." In the post-industrial era, IT workers have skills that allow them to compete in the global labor market, as IT jobs, by their very nature, are not tied to any particular culture and "can work" anywhere. At the same time, IT production is labor-intensive, and many first-world nations (Britain, Germany, France, Ireland, the U.S.), which have undergone a reduction in birthrates, feel that their own human resources are not sufficient for its development. In 2000, the American Institute for Electric and Electronic Engineers (IEEE) recognized that "With declining numbers from national engineering graduate programs, the U.S. has no option but to satisfy the growing need for the engineering professionals from abroad" (Institute, 1999). To bring professionals into the country, the U.S., the biggest IT developer, introduced an employer-based H1-B visa program for specialty occupations (e.g., computer professionals, programmers or engineers).

BACKGROUND

In the U.S., visa petitions by IT specialists are approved for up to 3 years and may be extended to 6 years. During this period, the employee cannot change the employer, but (potentially) may get a permanent residence permit (i.e., a Green Card). The 1990 ceiling for admissions was set at 65,000 a year, and in 1997, "for the first time, the maximum limit was reached by the end of the year; in 1998 the ceiling was reached in May" (Immigration, 2003, p. 45), and employers complained of shortages. The 1999 limit of 115,000 was exceeded by 20,000, and in October 2000, the U.S. Congress passed the American Competitiveness in the 21 Century Act, increasing the annual limit to 195,000 for 2001, 2002 and 2003 (Immigration, 2003). Following that year, H1-B "cap" was set to return to 65,000 in fiscal year 2004, and U.S. Citizenship and Immigration Services received enough H1-B petitions, issued by U.S. employers, to meet the congressionally mandated number on February 17, 2004 (USCIS, 2004).

According to various sources, India provides 33% to 47% of U.S. high-tech employees with H1-B visas. The next-biggest supplier of IT developers is China, with about 9%, with Japan, Taiwan, Great Britain, Canada and South Korea providing 2% to 3% each. In recent years, specialists from Eastern Europe, mainly from Belarus, Russia and Ukraine, have also become a visible group. These nations are now becoming aware of the "brain drain" to the West (International, 2002; Ferro, 2004).

American society is experiencing profound effects from and is concerned with this type of migration. There is controversy over whether the system brings more benefits than losses (Saxenian, 2002) and how it may affect the most vulnerable, mainly older, U.S. IT workers, who may not be retrained but "substituted" by younger, educated foreign nationals (O'Lawrence, 2001). Responses to Senator Phil Gramm's introduction of a bill to raise the number of temporary high-tech guest workers were published in the IEEE newsletter, *The Institute,* in 1999 under the headline "Stop the Insanity of H-1B!" (Institute, 1999). The conflict in how to view the H1-B program is part of a much larger issue; in the era of mobile labor force, individual states stopped being basic units of capitalism, while the government can only protect their workers within the frameworks of national systems of social justice (Rorty, 1998).

CURRENT TRENDS

The employment-based relocation of IT specialists to the U.S. is a highly gendered phenomenon. Spouses (and children) are only allowed to follow relocating programmers as "dependents" on H4 visas, which do not include the right to work. Overtly gender-neutral, the system is based on the assumption that programmers are male, for their professional spatial mobility is more socially acceptable than women's: Men are not supposed to follow women as nonworking "dependents," and such cases are rare (Gapova, 2004). Thus, the H1-B system derives from the idea of a certain family pattern, reflecting and strengthening an underlying gendered division of labor. While IT workers (i.e., men) relocate as professionals, spouses (i.e., women) follow them as caretakers and providers of intimacy.

In the globalized world, the value of human intimacy and chains of care is high (Rotkirch, 2000; Parrenas, 2001). Sometimes the relocation prospect serves as a "catalyst" to move from partnership to legal marriage, which otherwise might not have taken place. Men, unhappy about being on their own in a strange country, are often doubtful about their value in the U.S. marriage market and how to find new partners there. When interviewed, most post-Soviet H1-B visa holders emphasize the value, in the foreign lands, of the intimacy and human bondage that women provide, and many stress the need of a loyal partner as an important precondition for their very successful professional functioning (Gapova, 2004).

Women's consent to follow as "dependents" may be conditioned by several considerations, the following two being most important: (1) their own professional status and career opportunities at home; and (2) the age of children, of whom they take care more than men do. Wives with a (professional or advanced) degree and realistic career options view relocation as not bringing them personal professional gains, and such couples tend to reject the idea. Most women, though, being in their late 20s or early 30s, are too young to have developed a real career, so it looks like "there's nothing to sacrifice." Also, the money that the family can make under the new arrangement is a factor. As IT jobs are better paid than those done by women (whose occupation tend to be more bound to teaching, culture, healthcare, etc.) back home, it is women's jobs that are normally sacrificied "for family's sake." The leap form a dual career to a single earner family, conditioned by the H1-B system, is justified by a much bigger male wage (Gapova, 2004).

The individual social mobilities in such couples are "opposed" to each other. The man's social wealth derived from his work status is rather high and his class mobility tends to be upward: He is a professional in a prestigious field and the breadwinner. The woman's social mobility is contradictory, simultaneously being upward and downward. While the family's general financial situation improves, women on H4 visas depend on the male wage and have certain financial stability only as family members. Their occupational difference is converted into status inequality. Gapova (2000) writes about the vulnerability of post-Soviet H4 visa holders. Assisi (2004) claims human rights violations among H1-B visa holders' spouses, and Raj (2003, 2004) states that partners of South Asian women on dependent spousal visas may use immigration laws prohibiting them from working to limit their autonomy, or even resort to violence.

CONCLUSION

Global production of IT is involved with movement of skilled labor across space; namely, the physical migration of (mostly male) high-tech professionals to North America and Western Europe from post-socialist countries, India and China on specialty professional visas. A certain concept of gender roles underlies the seemingly neutral migration arrangement. The system is constructed to strengthen a certain family form, globally producing men as professionals and women as biological reproducers and primary caregivers, thus ensuring the (re)production of IT labor force and a certain gender hierarchy, which may be partially dealt with through policy solutions.

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KEY TERMS

Brain Drain: The loss of skilled intellectual and technical professionals through the movement to more favorable geographic, economic or professional environments. The term originated about 1960, when many British scientists emigrated to the U.S. for a better working climate. Also termed human capital flight**.**

Green Card: Permanent residence permit. Issued to different categories of people, including those coming to the U.S. by marriage or as family members, priority workers, skilled workers, members of the professions holding advanced degrees or persons of exceptional ability, refugees and others.

H1-B Visa Program: Intended to bring into the country workers in specialty occupations; for example, computer professionals, programmers or engineers. H1-B is a temporary work visa for skilled professionals.

H-4 Visa: May be granted to a spouse and any unmarried children younger than 21 years of age of an H1-B holder. A person with an H-4 visa may not work unless the person qualifies for an H1-B visa and is approved for a "Change of Status" by the "Immigration and Naturalization Service. H-4 holders are able to acquire a driver's license, open a bank account and go to college.

Knowledge Worker: Anyone who works for a living at the tasks of developing or using knowledge. A term first used by Peter Drucker in 1959, the knowledge worker includes those in the IT fields, such as programmers, systems analysts, technical writers, academic professionals, researchers and so forth. The term is also frequently used to include people outside of IT.

Motivating Women to Computer Science Education

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INTRODUCTION

The problem of disproportional representation of women in the computer science (CS) field in post-secondary education has become a major concern (AAUW, 2000; Camp, 2002; Carver, 2000; Varma, 2003). Currently, universities are increasing their focus on retaining women into CS programs. However, the number of women in that field remains low in proportion to males, and many women who are recruited often drop out or switch majors before completing their degree in CS (National Science Board, 2004, pp. 2-6, 3-17). In order to promote retention, it is important to compare possible differences in learning motivation between males and females in CS, examine changes in motivations across the span of CS study, and assess whether recruitment messages and program structures are matched (or mismatched) to the motivations of females. This article investigates the motivations for women to enter into, remain in, and continue the study of CS at the post-secondary level.

BACKGROUND

In recent years, a number of researchers (Chory-Assad, 2002; Kerssen-Griep, Hess, & Trees, 2003; Noels, Clement, & Pelletier, 1999; Postlewaite & Haggerty, 2002; Volet, 2001) have specifically concentrated on motivations for learning in the classroom and the factors that match teaching techniques with student success and satisfaction. Motivation, in the context of learning, refers to stimulation that drives students to derive academic benefits from classroom activities. In a learning setting, motivation can also be described as either trait motivation, a general level of desire to learn across all learning situations, or state motivation, a general level of desire to learn in a particular class, task, or content area (Anderson & Martin, 2002). The present study probes state motivations rather than trait motivations because of the focus on motivations that are particular to choosing and continuing study in the CS field.

Several scholars have posited a variety of theoretical constructs centred on state motivation. One such construct is the achievement goal theory (Dweck & Leggett, 1988), which reasons that goals are either ego oriented, wanting to gain favourable judgments of competence through social comparison, or task oriented, wanting to be competent and master a skill through effort based on internalized standards. In this construct, the general attitude towards reaching the goal is important. Another construct is self-determination theory (Deci & Ryan, 1985), which includes categories of intrinsic and extrinsic motivations. An educationally based construct is that of Pintrich, Smith, Garcia, and McKeachie (1991) who developed the Motivated Strategies for Learning Questionnaire. The bases for these scales are internal and external goal orientations. This instrument is currently the measurement standard for motivation in education.

Demonstrating how the interaction between internal and external attitude orientations and rewards might create a broader range of motivational categories requires a more complete explication. Vallerand and Bissonette (1992) posit a matrix which puts forward three types of extrinsic motivation: (1) external regulation (influences from means outside of the individual such as reward and punishment), (2) introjected regulation (results from outside pressure that the individual has internalized such as guilt or desire to impress others), and (3) identified regulation (whereby the individual feels that something is personally worthwhile and relates to their value system). This matrix has been related to second language learning, a learning situation similar to CS because it involves a very specific content area where motivational factors may be highly determinate in the success or failure of learning.

Volet (2001) modified Pintrichs et al.'s (1991) "Self-Efficacy and Expectancy of Success" as a measure of motivation. Self-efficacy describes a student making a judgment about his or her own ability to be successful in a learning task. Self-efficacy is posited to be an important motivation for both entering into and continuing in a particular learning context. The Williams and Ivey (2001) case study of motivations in math education also concentrated on an internal motivation orientation that includes self-efficacy as a factor. They highlighted an internal perception of usefulness as an essential part of the motivational matrix. A perception of usefulness is whether the student perceives that the particular skill to be learned will have a current or future utility for them. As with math, a perception of usefulness may also be an important motivational factor in continuing in the study of CS.

Margolis and Fisher (2002) posit that males and females have different motivations for entering the study of CS. They developed a set of seven motivational factors for the study of CS: enjoyment, versatility, math/science related, employment, encouragement by others, exciting field, and the quality of CS department. While both males and females list enjoyment as their top motivation, the most important difference is that females list the versatility (utility and purpose) of computing as their secondary reason, while male's rate this motivation as sixth. In programming, males and females named self-efficacy as a motivation, but males cited this to a lesser degree.

Yet scholars have not investigated the role of motivation in both the recruitment and retention of women in CS program. As a synthesis of the various literatures on motivation, and with the specific motivation for CS, this study offers a motivation matrix that can be utilized to measure motivations across time because it encompasses a broad range of state motivational behaviors within a restricted number of concepts. This matrix includes three intrinsic and three extrinsic motivations, listed as intrinsic-self, intrinsic-social, intrinsic-economic, extrinsic-self, extrinsic-social, and extrinsic-economic.

To analyze motivation in both the recruitment and retention of women in CS, it is essential to investigate possible changes in motivations over time, given the interaction of other factors such as success in the classroom or desires for challenge and fun. Time parameters in the present study are before enrolment and during CS coursework.

METHOD

The present study hypothesizes the following relationships:

- **H1:** Females and males will differ significantly on intrinsic-self motivation in CS study.
- **H2:** Females and males will differ significantly on intrinsic-social motivation in CS study.
- **H3:** Females and males will differ significantly on intrinsic-economic motivation in CS study.
- **H4:** Females and males will differ significantly on extrinsic-self motivation in CS study.
- **H5:** Females and males will differ significantly on extrinsic-social motivation in CS study.
- **H6:** Females and males will differ significantly on extrinsic-economic motivation in CS study.
- **H7:** Motivations to study CS will differ across time based on gender.

The participants in the present study were students in CS at four institutions of higher education designated as minority-serving institutions because existing studies have focused mostly on non-minority institutions. The total sample size was 66, which included 35 female and 31 male participants. The sample was ethnically diverse with 22 White (11 female, 11 male), 15 African American (seven female, eight male), 10 Hispanic (five female, five male), 10 Native American (eight female, two male), and nine Asian American (four female, five male) participants.

The data for this study was gathered in 2002-2003 through in-depth interviews, as part of a larger project on women in information technology. Each student was asked the same 61 questions and 15 of those questions provided the specific data about motivations to study CS. Each interview was audio taped and transcribed verbatim. Random sampling was used to select subjects representing sufficient numbers of women and men. However, purposive sampling was used when the numbers of students majoring in CS was small (e.g., Native Americans).

A content analysis coding scheme was developed based on six motivation variables: (1) *Intrinsic-self*—"I love the challenge," "Computers are interesting;" (2) *Intrinsic-social*—"I want to be able to use it to help my community," "I'll do programming if it relates to human rights;" (3) *Intrinsic-economic*—"I've always been good at," "I made it work," "I played with it until I figured it out;" (4) *Extrinsic-self*—"I can use it no matter what work I do after this," "They teach you how to think so you can apply it to any situation," "It's something practical;" (5) *Extrinsic-social*—"I want to show that I am just as good as the guys," "I do it because I have to," "My dad really encouraged me;" and (6) *Extrinsic-economic*—"I can make a lot of money," "It will be easy to get a job," "I need a good grade."

One category was designated for each type of motivation. This created six categories. Any statements that could be coded in any of the six categories were coded only once in a single category, creating an exclusive coding system. Each respondent was designated with a numeric label (1-66) and each interview question was given an alphabet designation. Therefore, each coded statement was given an alphanumeric label. Designation of the two phases of study was accomplished by separating the types of interview questions into two categories—motivations related to the pre-study stage and motivations during CS study. Two trained coders coded the interviews to ensure coded data are consistent with each other. Intercoder reliability (Lombard, Snyder-Duch, & Bracken, 2002) for each category was assessed using Scott's P, and reliability was established between coder one and coder two. Reliability for intrinsic-self was 0.94; for intrinsic-social was 0.87; for intrinsic-economic was 0.755; for extrinsic-self was 0.925; for extrinsic-social was 0.97; and for extrinsic-economic was 0.80. Overall, reliability was 0.88. All of these values are within the acceptable range for reliability. A total of 495 items were coded.

FINDINGS AND DISCUSSION

Demographic information was gathered in order to self-report socio-economic background of parents, age range for traditional or non-traditional student, prior exposure to computers, marital and family status, occupations of parents, year in school, educational major, student status (full or part time), and employment. A cross tab calculation was performed on all of the demographic variables in relation to gender to check for distribution across the sample. No significant relationships were found, eliminating these for consideration as intervening variables.

Hypotheses two, six, and seven were supported; hypothesis one was not supported but a near-significant difference was noted; hypotheses three, four, and five were not supported (Table 1). The second hypothesis predicted that females and males would differ significantly on the measure of intrinsic-social motivation. There was a significant difference between females and males in intrinsic-social motivation in the enrolment phase of CS (X^2=5.128, p<.05). Males were more likely to cite motivations for enrolment that indicated the importance of CS as personally worthwhile and relating to their own value system. There was no significant difference in this measurement during CS study

Table 1. Bivariate relationship for gender and motivation for pre-enrolment and during study in computer science

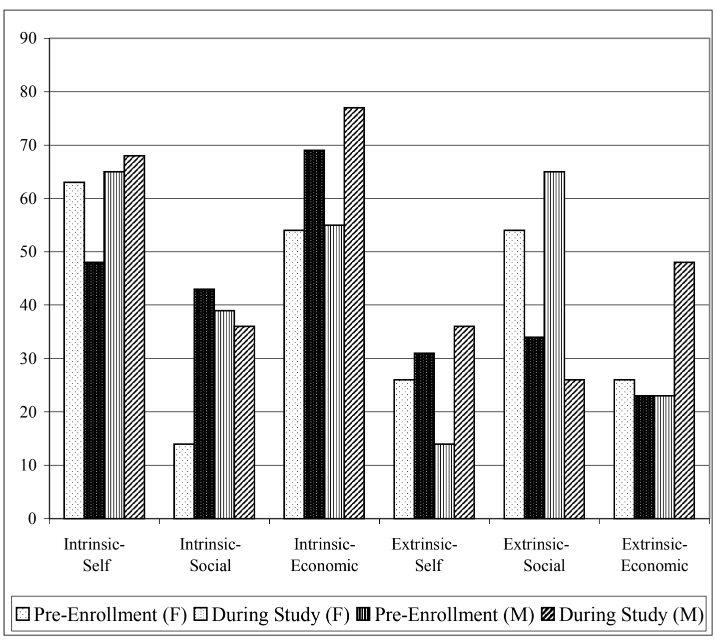
	Intrinsic-Self χ^2	Intrinsic-Social χ^2	Intrinsic-Economic χ^2	Extrinsic-Self χ^2	Extrinsic-Social χ^2	Extrinsic-Economic χ^2
Gender- Pre-Enrolment	0.020	5.128	0.002	0.004	0.712	0.088
Gender-During Study	3.41	0.374	0.649	0.122	0.560	4.71

Note: Significant relationships (p<.05) are shaded.

phase. Hypothesis six predicted that females and males would differ significantly on the measure of extrinsic-economic motivation. There was a significant difference between females and males in extrinsic-economic motivation during the CS study phase (X^2=4.71, p<.05). Males were more likely than females to cite the anticipation of a tangible positive result (a job) as a motivation for continuing the study of CS. The first hypothesis that predicted females and males would differ significantly on the measure of intrinsic-self was not supported, but showed a near-significant difference (X^2=3.411, p<.05).

Hypothesis seven posits that motivations differ depending on whether they are measured when contemplating enrolment in CS or during actual engagement in CS study and it was supported (Table 2). For females, there was a drop in their motivation based on intrinsic reward (In-Self) from 63% pre-enrolment to 48% during study. Statements regarding loving the challenge or thinking that computers were interesting dropped by 15%, while for males these statements increased by 3%. Motivation statements also decreased for females but went up for males judging tangible material rewards (extrinsic-economic). Females' statements dropped by 3%, while males' statements increased by 25%. This difference is consistent with the difference in the respondents reporting work in the field of computers during study. Only 57% of females had related jobs while 87% of males did. Motivation based on a match between personal values and the study of CS (Intrinsic-social) increased 29% for females, while there was a slight drop (3%) for males. Motivation based on females' perceived fit between their own values and what CS could do for them increased dramatically once they were in the field of study. There was an increase for both males and females from pre-enrolment to course study in their personal judgments of their own ability (intrinsic-economic) in CS. Although both females and males were at about the same level prior to enrolment, male judgments of success increased by 22% while female judgments of success increased by only 15%. The perceived utility of CS skills (extrinsic-self) also increased for both males and females, but less so for females (5%). Male motivation statements regarding perceived utility increased by 22%. Extrinsic social influences as a motivation (i.e., impressing friends and family), went down for both males and females once they started their studies. However, it fell more for males (39%) than for females (20%). Outside social influences remained a higher motivation for females than for males.

Table 2. Changes in motivation to study CS across time by gender



The purpose of the study was to investigate motivation factors among genders in the study of CS at two stages of post-secondary education and to investigate how motivations vary. First, this study proposed a new matrix of state motivations broad enough to measure consistently across time periods, yet confined to six categories of motivation. These six motivational constructs examined both intrinsic and extrinsic motivations and were measured across time. The results indicate that motivations change between contemplation of studying CS and the actual engagement in study. This suggests that varying strategies, aimed at different motivations, can be utilized to recruit and then to retain women in CS.

The findings in the current study correspond with the findings of Margolis and Fisher (2002) in which both males and females cited intrinsic-self (e.g., enjoyment) as their primary motive for enrolment. However, this did not hold true for motivation during study when ability (intrinsic-economic) became the top motivation for both. Additionally, Margolis and Fisher (2002) found that extrinsic-self (e.g., versatility) was the secondary motivation for females, but the sixth motivation for males. In contrast, the present study indicated no significant difference between males and females on this measure during enrolment or study. However, there was a significant difference between males and females in the enrolment motivation that Margolis and Fisher (2002) attribute to respondents wanting to enter a field that matches their values. Males were much higher on this measure in the enrolment phase and then levelled out with females during the study phase of CS. Females did not cite this as an initial motivation, yet this area had the highest increase for females once they began study in the field. Therefore, it may be that CS programs need to incorporate connections between CS skills and female social values, or demonstrate in practical terms how social values can be met through the field of CS.

Second, while there was no significant difference between males and females during enrolment based on judgments of intrinsic interest in computers and CS, there was near-significant difference once they began CS study. Female estimations of loving computers and finding the challenge rewarding dropped a great deal more than it did for males. To retain women in CS, this factor needs further assessment.

Finally, the appraisal of tangible material rewards during study showed a significant difference between males and females. Female judgments of tangible reward remained fairly stable while male estimations jumped upwards. As noted earlier, this coincides with information about males having more employment and internships in computer related fields than females while they are studying. There is some indication that work opportunities do not fit the lives and schedules of female students. Childcare and family responsibilities may be a factor in whether or not women get internships or available jobs. This could subsequently affect their motivation to remain in the CS field.

FUTURE TRENDS

In the past, efforts at recruiting and retaining women in CS have concentrated on providing early hands-on computer experiences and recruitment into programs. This approach supposes that a critical mass of women will provide a community of scholars that will support each other. Some of these efforts have been successful, but do not consider other possible factors, including the motivations that students have for studying CS and how these motivations are, or are not, matched to recruitment and retention strategies. Faculty, advisors, and administrators need to take a careful look at these factors when modifying programs that are not acting to retain women in CS field.

CONCLUSION

The study shows that it is not enough to look at a single time construct of motivation. As experiences and contexts change students modify their own estimations of the motivations that drive them. Recruitment techniques that concentrate on appealing to women's needs to enjoy and find a challenge in computers does not work to retain them once the reality of spending hours in front of a computer sets in. At that point, an increase in the activities that connect computing to both real world problems and real world employment need to be the focus of retention efforts.

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KEY TERMS

Extrinsic-Economic: Refers to motivation that is determined through means outside of the individual such as a tangible positive result.

Extrinsic Motivation: Refers to as motivation that is determined through means outside of the individual; behaviours that are performed in order to arrive at some instrumental end.

Extrinsic-Self: Refers to motivation that is a result of projecting into the future as to whether a skill will have an utilitarian purpose.

Extrinsic-Social: Refers to motivation that is a result of an outside force that the individual has internalized such as guilt or desire to impress others.

Intrinsic-Economic: Refers to personal judgment of ability to do and be successful at a particular activity.

Intrinsic Motivation: Refers to the performance of an activity for the pleasure and satisfaction that accompany that action; fulfilling innate needs for competence and self-determination.

Intrinsic-Self: Refers to the performance of an activity for the pleasure and satisfaction that accompany that action.

Intrinsic-Social: Refers to motivation whereby the individual feels that something is personally worthwhile and relates to their value system.

Multi-Disciplinary, Scientific, Gender Research

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INTRODUCTION

Many phenomena of interest in education research are results of voluntary human action: whether a first-year college student elects to pursue a degree in information technology or not, whether the pursuit is in computer science vs. computer engineering, and whether the student will persist in a discipline throughout her or his college matriculation or change disciplines after a year or two. Although the human action is observable and can be tracked, the reasons an election is made and when it is made are not easily modeled. This article describes the design of a multidisciplinary, scientific study of gender-based differences, and ethnic and cultural models in the computing disciplines. The term computing disciplines is a collective one subsuming for ease of discussion the various disciplines that have evolved from the mid 20th century through the present 21st century, for example, computer engineering, computer science, computer information systems, information science, information technology, telecommunication systems management, and so forth. The researchers and study advisors formed a multidisciplinary team that is investigating in a scientific way the psychological, social, and educational rigidities that might exist between computing disciplines, and in so doing is developing different predictive models for women and ethnically underrepresented groups, in particular, African Americans. The article highlights recognized guiding principles for conducting scientific research in education and explains how the guiding principles have been implemented thus far in the study.

BACKGROUND

In 1959, as part of a prestigious lecture series at Cambridge University, Professor C. P. Snow, a recognized physicist and poet, gave a talk entitled "The Two Cultures" (Snow, 1964). Professor Snow expressed his concerns regarding the growing gap between the scientific and literary intellectuals of the time. He hypothesized that the reasons for the divide were a belief in educational specialization and a tendency to allow social forms to "crystallize." He suggested that once a cultural divide is established, all the social forces operate to make it more rigid and enduring.

Professor Snow's observations and hypotheses might well be applied generally to today's growing gap between women and men in the computing disciplines. However, the cultural divide may indeed go beyond gender differences, existing between specific computing disciplines (e.g., between computer engineering and information technology) or between types of institutions of higher education (e.g., between historically black colleges and universities [HBCUs] and predominantly white institutions [PWIs]), or it may exist in some other tier of the multilayered educational experience of the person (Lopez & Schulte, 2002). Researchers have documented the influence of culture: institutional culture (Barker & Garvin-Doxas, 2003), departmental culture (Meeden, Newhall, Blank, & Kumar, 2003), and computing discipline culture, that is, the human centric vs. math-science centric (Denning, 2001). The concept of culture seems to be associated with gender and ethnicity as well, playing a role in African American women attending HBCUs or PWIs (Constantine & Watt, 2002).

In a group of people, a culture develops from ongoing group discussions about values, meanings, expectations, and prevailing unwritten rules, thus affecting the perceptions, appraisals, and behavior of individual members of the group (Seel, 2000). Through learning and socialization, people internalize either consciously or unconsciously patterns of culture. The consequences of culture are that studies, say, involving the STEM disciplines (science, technology, engineering, and mathematics), may produce findings that may or may not translate into valid conclusions for all or some of the computing disciplines. Likewise, even studies in a specific computing discipline involving subjects from only PWIs may produce findings that may or may not transfer to HBCUs. The cultural divides in the computing disciplines exist because of the educational specializations that have been constructed. As Professor Snow suggested, the socialization process (i.e., the daily conversations and negotiations among the group members as well as between group members and nonmembers) will endeavor to make these divides more rigid. Consequently, extreme care must be taken in educational studies to delineate the conditions under which findings are applicable. Furthermore, large studies spanning a wide geographic area (e.g., the United States) over several years are needed to attempt to grasp the influence of culture in the computing disciplines.

MAIN THRUST OF THE ARTICLE

Forming a Multidisciplinary Team

Research in education must concern itself with the physical, social, and economic environments in which the research is conducted because contextual factors often influence research results in significant ways. For example, care must be exercised when using data collected from the computing disciplines before 2000 and 2001 (i.e., the dot-com bust and the 9/11 terrorist attack on the World Trade Center period) to draw inferences about the student population of the computing disciplines today. The economic markets that influence recruitment into the computing disciplines have changed significantly since that time. Thus, research on human action must take into account a number of contextual factors as well as the individual's understanding, intentions, and values. Consequently, studies must be multidisciplinary.

The remainder of this subsection describes the multidisciplinary team assembled under a National Science Foundation (NSF) grant to conduct a study on gender-based differences, and ethnic and cultural models in the computing disciplines. The principal investigators (PIs) are Antonio M. Lopez, Jr. (professor and the Conrad N. Hilton endowed chair in computer science), Lisa J. Schulte (associate professor and chair of psychology), and Marguerite S. Giguette (professor and the BellSouth distinguished professor in computer science). All are from Xavier University of Louisiana.

The advisory board is a highly skilled, multidisciplinary group that can help address the physical, social, and economic environments.

Sylvia Beyer, associate professor of psychology, University of Wisconsin-Parkside. Her research focuses on gender differences in self-perceptions in male-dominated domains.

Doris Carver, professor of computer science and associate vice chancellor of research and graduate studies, Louisiana State University. She is an IEEE fellow and editor-in-chief of *Computer*.

Joanne Cohoon, research assistant professor in the Curry School of Education, University of Virginia. She is a sociologist who studies technology, gender, education, and their interaction.

Andrea Lawrence, associate professor and chairperson of computer science, Spelman College. She is the president of the Association of Departments of Computer and Information Sciences and Engineering at Minority Institutions.

Jane Margolis, research educationist, University of California Los Angeles, in the Graduate School of Education and Information Studies. She recently conducted an investigation of African American and Latino male and female high-school students' decisions to study (or not study) computer science in three public Los Angeles high schools.

Bradley Jensen, academic relationship manager, Microsoft, Inc.

Alfred Zenon, logistics engineer, Apogen Technologies, Inc.

Since Xavier University of Louisiana is not a Research I (Carnegie classification) institution, research partners were recruited to help the PIs develop the investigation methods to be used and to analyze the data collected. The research partners are as follows.

Madonna G. Constantine, professor and chair of the psychology department, Columbia University. She is a fellow of the American Psychological Association (APA) and codeveloper of the Cultural Congruity Scale. She is a consulting editor for the

Journal of Cultural Diversity and Ethnic Minority Psychology and an associate editor for the *Journal of Black Psychology*.

Robert W. Lent, professor and the director of counseling psychology for the Department of Counseling and Personnel Services, University of Maryland, College Park. He is an APA fellow and a codeveloper of the social cognitive career theory (SCCT). SCCT attempts to explain how people develop their academic and career interests, how they translate those interests into career choices, and what additional influences, such as cultural and environmental factors, contribute to their choices and achievements at school and work.

Frederick G. Lopez, professor and the director of training in counseling psychology for the Department of Educational Psychology, University of Houston. He is an APA fellow and codeveloper of the Academic Hardiness Scale. He is a former Fulbright senior scholar (Portugal), and a member of the editorial board of the *Journal of Counseling Psychology*.

Blueprint for Scientific Research

According to scholars at the National Research Council (Shavelson & Towne, 2002), the prevailing view with regard to findings from research studies in education is that the findings are of low quality and are endlessly contested. They state that one reason research in education is highly contested is the central role of values; people's hopes and expectations regarding education are tied to their hopes and expectations about the direction of society. Naturally, these values can be some overlapping set, superset, or subset of the values that are creating the various cultures surrounding education. One of the conclusions drawn is that in this complex world, there is an understandable attraction to the rationality and disciplined style of scientific research in education. The text gives six guiding principles that make a study of an educational process a scientific research study.

1. It poses significant questions that can be investigated empirically.
2. It links research to relevant theory.
3. It uses methods that permit direct investigation of the questions.
4. It provides a coherent and explicit chain of reasoning.
5. It replicates and generalizes across studies.
6. It discloses research to encourage professional scrutiny and critique.

Researchers studying the computing disciplines must take these guiding principles to heart.

Implementing Guiding Principle #1

"The Incredible Shrinking Pipeline" (Camp, 1997) was the title of a paper that drew attention to the decreasing population of college women majoring in computer science in the United States. Studies in the United States have continued to focus on the computer-science pipeline (Beyer, Rynes, Perrault, Hay, & Haller, 2003; Cohoon, 2001; Margolis, Fisher, & Miller, 2000). However, outside the United States, studies have taken a broader computing-disciplines approach (Adams, Bauer, & Baichoo, 2003; Cukier, Shortt, & Devine, 2001; Galpin, Sanders, Turner, & Venton, 2003). In fact, a Canadian study (Cukier et al.) found that a narrow definition of computing disciplines (e.g., just computer science) marginalizes women and their contribution, noting that the language of technology reflects and shapes the culture. Only recently have United States researchers in gender-based differences (Lopez, Schulte, & Giguette, 2005; Randall, Price, & Reichgelt, 2003) begun to differentiate between the various computing disciplines.

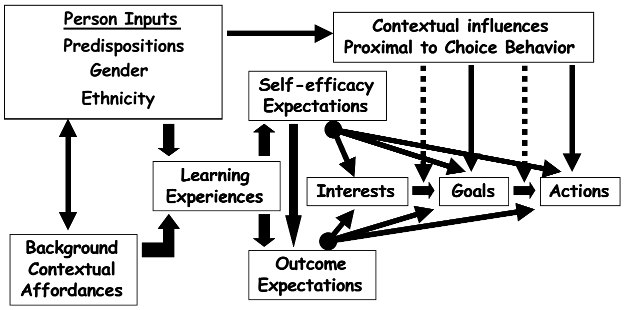
A list of variables that seem to have an impact on the computing disciplines' pipeline has emerged from these and other research publications (Beyer, De Kenster, Walter, Colar, & Holcomb, 2005; Cohoon, 2002; Kahle & Schmidt, 2004; Margolis & Fisher, 2002; Rowell, Perhac, Hawkins, Parker, Pettey, & Iriate-Gross, 2003). Some of these variables are collective self-esteem, computer self-efficacy, coping self-efficacy, gender roles, goals, interests, mathematics self-efficacy, outcome expectations, self-efficacy, social support and/or barriers, and stereotype threats. These variables need to be investigated in the specific context not only of gender but ethnicity and culture as well. Thus, some research questions are the following. Which of the previous variables, if any, predict the perseverance of African American women in computer engineering? Is it the same variable or set of variables that predicts the perseverance of African American women in information technology? How strong is the stereotype threat for African Americans in computer science vs. computer information systems?

Implementing Guiding Principle #2

The SCCT is at the heart of the present study. SCCT consists of three overlapping models aimed at explaining the processes through which people (a) develop basic academic and career interests, (b) make and revise their educational and vocational plans, and (c) achieve performances of varying quality in their chosen academic and career pursuits (Lent, Brown, & Hackett, 1994). Self-efficacy (in particular, coping self-efficacy), outcome expectations, interests, and goals play key roles within each of these three models, operating in concert with a variety of additional personal, contextual, and learning variables (e.g., gender, ethnicity, social support/barriers, etc.) to help shape people's career development (see Figure 1).

SCCT maintains that people develop interests in activities in which they believe they can perform effectively and for which they anticipate receiving positive outcomes. The theory focuses on several cognitive-person variables (e.g., self-efficacy, outcome expectations, etc.) and how these variables interact with other aspects of the person (e.g., gender, ethnicity, etc.). Contextual influences, in particular, proximal ones (e.g., role models, faculty encouragement, etc.), are important during decision making. Recent findings (Lent, Brown, Schmidt, Brenner, Lyons, & Treistman, 2003) indicate that SCCT variables were strongly predictive of engineering students' persistence goals across genders and university types (i.e., HBCUs vs. PWIs).

Figure 1. Component view of SCCT



Stereotype threat is another theory embedded in the study. Stereotype threat is defined as the danger of being viewed through the lens of a negative stereotype, or the fear of doing something that would inadvertently confirm that stereotype (Steele, 1997). Steele suggests that stereotype vulnerability might explain the decline of interest among some groups in specific fields, especially among women in male-dominated fields and among African Americans in academic settings in general.

There are other theories embedded in the present study, but space limits their exposure here. Suffice to say, the theories being supported by the collected data will be those propagated in future research.

Implementing Guiding Principle #3

The research methodology is a mixed design, primarily a three-year longitudinal study with a new sample of first-year undergraduates being introduced in the second and third years. The project seeks to involve a total of 50 institutions of higher education from across the United States. Twenty-five of these institutions are HBCUs and 25 are PWIs. Every year of the study, each institution will have approximately 70 of their computing-discipline undergraduates (both male and female) surveyed; these subjects will range from first-year students to seniors. For comparison each year, 30 first-year undergraduates from noncomputing disciplines (e.g., psychology, music, education, etc.) at each institution will also be surveyed.

Two colleagues from each of the 50 institutions help coordinate the study. These faculty members are critical to the success of this project because they serve as the vital link to the target population. At each institution, one colleague is from a computing discipline and the other from a noncomputing discipline. The computing-discipline faculty member will support the longitudinal segment of the project, while the noncomputing-discipline faculty member will support the successive independent samples of the noncomputing-discipline students.

The prepared surveys are on the World Wide Web, protected via a unique user log-in and a secure socket with certificate verification. Several versions of the two basic surveys (one for computing-discipline participants and one for noncomputing-discipline participants) are used to balance order effects. Participants may complete the survey at their convenience. The survey takes less than 30 minutes to complete. On submitting the survey, an e-mail voucher for $10 is sent, whereby the participant can print it out and take it to the faculty member for authorization and collection of compensation.

FUTURE TRENDS

The data collection for the first year of the described study ended on January 31, 2005. The PIs and research partners are analyzing the data at the present time. Once the evidence is available, the team will endeavor to provide a *coherent and explicit chain of reasoning* between evidence and theory. Some theories may be strengthened, others modified, and yet others discarded. The longitudinal nature of the study will allow the possible *replication and generalization* of results over time. At the same time, others may elect to use the SCCT or stereotype threat in their own large studies, and this will allow further comparison of results across studies. Finally, papers written and published by members of the study's multidisciplinary team will disclose the research and encourage multidisciplinary *scrutiny and critique*.

The National Research Council guiding principles provide a strong framework on which to construct an understanding of the computing disciplines' pipeline. It is expected that the study described here will be one of many that advance such knowledge in a scientifically rigorous and self-correcting manner. Ultimately, the findings will affect policy makers who fund and/or direct future education in the computing disciplines.

CONCLUSION

This article describes the cultural lenses through which a multidisciplinary research team is studying the computing disciplines' pipeline. The study follows the National Research Council guidelines for scientific research in education. The article shows how the first three guiding principles were implemented in the study. The future will see the implementation of the last three guiding principles.

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KEY TERMS

Collective Self-Esteem: The value that individuals place on their own cultural groups.

Culture: A group-held set of values, meanings, expectations, and unwritten rules that affect the perceptions, appraisals, and behaviors of individual group members.

Gender Roles: A set of social, behavioral norms associated with a given gender.

Outcome Expectation: The extent to which one believes that one's action will bring about a certain result.

Self-Efficacy: An individual's judgment of her or his ability to produce a desired effect. Domains particularize the definition (e.g., coping self-efficacy, computer self-efficacy, and mathematics self-efficacy).

Social Barrier: Individuals or groups discouraging and/or working against one's effort to attain a goal.

Social Support: Individuals or groups encouraging and/or helping in one's effort to attain a goal.

Stereotype Threat: One's fear of doing something that would inadvertently confirm a socially held negative mental image of a group with which one shares certain characteristic qualities.

Native American Women in Computing

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INTRODUCTION

In the 1990s, a number of efforts had been made to increase the representation of women in computer science (CS) and computer engineering (CE) education, mostly to compensate for the expected shortfall of candidates from the traditional source: 18-year-old non-Hispanic white males. Yet, women remain underrepresented in the CS and CE disciplines. The underrepresentation of minority women is especially conspicuous and is absolutely glaring among Native American women. Though there are studies on the underrepresentation of women in CS and CE education, there are very few studies on minority women, and there is very little scholarly work on Native American women. Because Native Americans—officially classified as American Indians and/or Alaska Natives—are relatively small in number (1.5% of the U.S. population), they are seldom represented in assessments of gender and/or racial disparities in CS and CE education.

The educational attainment levels of Native American women have improved significantly over the last two decades. Despite these advances, the education level of Native American women remains considerably below the levels of the total population. They are less likely than the total population to graduate from high school, to enroll in college, and to graduate from college (Madrid, 1997). Native American women who do enroll in and graduate from college are less likely to be in science or engineering disciplines. Native American women who do graduate in science or engineering disciplines are less likely to be in CS or CE. For instance, in 2001, Native Americans earned only 271 bachelor's degrees in CS. Of these, Native American men earned 193 and women earned 78. Of incoming freshmen in 2002, only 4% of Native American men and 0.5% of Native American women intended to major in CS (National Science Foundation [NSF], 2004). This article discusses why so few Native American women pursue education in CS or CE disciplines after high school.

BACKGROUND

Most scholarly work on the underrepresentation of women in CS and CE education has been about the gender gap in science and engineering. It is generally assumed that many of the reasons that discourage women from science and engineering education also apply to CS and CE. When scholars have studied women in CS and CE disciplines, they have concentrated mostly on white women. If scholars have considered minority women, the focus has been on blacks and/or Hispanic women (e.g., American Association of University Women [AAUW], 2000; Howell, 1993; Margolis & Fisher, 2002; Martin & Murchie-Beyma, 1992; Moses, 1993; Spertus, 1991; Varma, 2002). These studies reveal gender bias in early socialization at home and in school, feelings of being deficient in mathematics and science, a lack of exposure to computers, the use of computers mostly for word processing, the masculine image of computers, and the absence of female role models—all of which contribute to the underrepresentation of women, including minority women, in CS and CE education. Though most of these barriers are likely to apply to Native American women, there may be additional historical and cultural factors that may play an essential role in their relative interest in CS and CE education.

Native Americans tend to maintain tribal traditions and connections to their tribal community. They are likely to live in what has been called "two worlds": the world of Native American ethos, which holds that sharing, generosity, and thinking as a group contribute to tribal community survival, and the world of American ethos, which values independence, individualism, and competition to enhance individual success (Benhaim & Stein, 2003). The Native American worldview emphasizes the importance of grasping the big picture before studying particular subjects (Megginson, 1990). Native Americans prefer harmony and group-oriented learning environments to environments that promote individual success (Anderson & Stein, 1992). As a result, Native American students may face more challenges in pursuing a major in a CS or CE discipline than whites, blacks, and Hispanics. Because of patriarchy, cultural values, and social norms, Native American women may have more problems studying CS or CE than Native American men.

This research explores different spectrums to explain the low representation of Native American women in CS and CE education at the undergraduate level. It is based on 50 in-depth interviews of Native American undergraduate students (25 females and 25 males) enrolled in a CS or CE program at six nontribal and tribal universities.

MAIN THRUST OF THE ARTICLE

Many interview students noticed that there are very few women studying CS or CE at their universities, and among the few women, very few are Native Americans. The majority of those who recognized a low number of women in CS and CE disciplines were female. Generally, students from nontribal sites were more likely to mention few women as being an issue than students from tribal sites. One female student said,

We are pretty rare in the computer program. Most of my classes, the ratio is like 1 to 10, 1 female per 10 male students ... These women are either white or Hispanic. I am the only Native woman in the class.

A male student observed, "I do not think there are any."

There are multiple reasons why there are few Native American women pursuing degrees in CS or CE programs. Because of the patriarchal way of life that dominates children's social and educational worlds, Native American women are historically seen as physically and intellectually less capable than men. Cultural and social notions about Native American women affect the way men view them in CS and CE programs. Although the majority of respondents (76%) indicated that they did not experience incidents related to gender in the CS and CE programs, gender bias and male preoccupations are prevalent among students. A closer look at the data shows that men's expectations and preconceived stereotypes about Native American women are more common than what the numbers might suggest.

For example, the majority of male students mentioned the gender bias was in favor of women. As one male student mentioned,

I often feel that [Native American women] have an advantage because of low male to female ratio ... In some sense they are more successful because they have all the resources from the smart guys who are always ready to help them out.

Another said, "I think [Native American women] get a lot more offers upon graduation than us because companies are trying to make their workforce diverse and it looks good to have Native American women." Another male student believed, "[Native American girls] receive favorable grades just because they are girls." These quotes show that what might appear as bias in favor of Native American women at first might not be the case at the end. For instance, the first student quoted mentions that girls are successful because they work with the "smart guys." In other words, Native American women succeed not because of their intelligence or hard work, but because of the help of somebody else, a smarter male specifically, and that special aid gives them an advantage over men.

Bias in favor of men differs greatly from bias in favor of women. While bias in favor of women relies on the help of others because of the inability of women to perform tasks by themselves, bias in favor of men is based on the simple fact that the student is male. As one female student said, "There is still a perception that males are bosses or think they have a better chance of getting further in their career." A male student believed, "Low representation of [Native American] women has to do with the scientific worldview. Because they don't have it, they encounter problems. Since most of us do have it, we don't encounter problems." So, a man's success in CS or CE depends solely on himself, whereas a Native American woman's success depends on acquiring the male scientific worldview. Such perceptions create an intimidating environment for Native American women. For the most part, more women from nontribal sites identified intimidation to be an issue than those from tribal sites. One female student said, "I have to always assure myself that I can do this, I am capable of doing this. I am doing the right thing by being here." Another echoed, "Sometimes, I am scared to speak, or ask questions, because what guys might think if I am wrong."

Yet, when asked if there is a difference in being a woman in a CS or CE program, almost one third of respondents said that there are no gender differences. Of those who believed that there are no gender differences, a large majority was women (58%). Nevertheless, a closer look at the responses of the female respondents shows that there is still a gender bias against women in CS and CE programs. For instance, one female respondent stated,

Well, I don't think that there is a difference in being a woman. I never thought about it. They treat me the same. I always get treated like one of the guys. I even forget that I am a girl.

This student mentions that there is no difference because she gets treated like "one of the guys" and she forgets she is a girl. Such statements show that even when women think that there are no gender differences, these differences are actually internalized. Women look up to men as the ultimate way to succeed in CS and CE programs. If there are no gender differences, why would a female student be pleased to be treated like a male? Or why would a female student forget that she is a female? By undermining their gender, female students have been able to transcend gender stereotypes. Some female students said, "[M]en look down at us just because we are females studying computers. Ironically, they have the power to look down at us."

Nevertheless, gender bias is not the only reason why Native American women are underrepresented in CS and CE programs. Cultural norms and early child socialization are important concepts to consider. There are strong patriarchal attitudes toward Native American women. As one female student said,

There is a disadvantage when you are a girl and you grow up in an unspoken way of life that doesn't allow girls to explore as much as boys would. So when girls get to college they might not have the skills to disassemble logic.

The underrepresentation of Native American women in CS and CE programs is in part a consequence of a historical Native American culture that favors men over women. Cultural patterns such as allowing men to "explore" more than women are closely linked to the different opportunities available to women and men. One male student acknowledged,

In general, computer science is not very attractive to women because it relates back to our culture. I am from Zuni and the women do not have a chance to learn the value of knowing how to program because of cultural aspects.

Another male student believed that "to do computer science, you need a scientific worldview. This is not what we teach our women." One female student regretfully said, "I just think a lot of parents don't encourage us to go in higher education or to study computers…They don't think it is really a woman thing to do."

Besides cultural aspects that do not encourage them to study CS or CE, Native American women face family and community challenges that other students may not. Family has been of paramount importance in Native American communities. The family structure tends to include extended family and several generations living in close proximity to each other. Women, especially grandmothers, play a key role in family affairs (Deloria, 1991). Native American women hold family together by taking care of elderly family members and/or children. They are responsible for exposing children to their traditions and ceremonies, and teaching Native American languages. Many females, mostly from nontribal sites, identified family affairs to be a barrier to success in CS or CE education. One female student stated,

Because it takes a lot of time, it takes a lot of effort on your part to study computer science; you have to figure out well in advance how you will handle your family matters and community events. Your study schedule has to have time for family and for community.

One male student described the situation like this:

Motherhood comes early for a lot of Native American females. So the success rate of women to get to the point of computer science is very low…Then family is always calling them back home for ceremonies or other matters so they just don't get through far enough into school to get to the point of actually doing computer science.

Cultural norms, early socialization, gender bias, and family matters are not the only factors creating obstacles for Native American women pursuing education in CS or CE; economics play a key role. The U.S. Bureau of the Census (2000) shows less education, lower earnings, more poverty, and poor health status among Native American women than the majority of the population. These economic difficulties experienced by Native American women are linked to the resources they are exposed to and the opportunities they have. It is well known that minority-serving schools, especially tribal schools, face the "digital divide" (Guice & McCoy, 2001). Still, because of socialization and cultural norms, Native American men get exposed to computers earlier than Native American women, and early exposure to computers leads to interest in a career in CS or CE. Female respondents cited a lack of exposure to computer technology more frequently than male respondents. Women from tribal sites cited a lack of resources more than those from nontribal sites. One male student acknowledged, "In order to be interested in computer science, women should be exposed to computers for a while. I mean, they are not cheap, and they are not everywhere. They are mostly in upper- to middle-class white households." One female student narrated, "Where I came from, it wasn't something that people thought about. I never really had heard of computers until I went to high school."

When Native American women do decide to study CS or CE, they are not appreciated within their family and community, mostly because "the image of a computer scientist is of white male." Native American women are often stereotyped as operating outside traditional norms if they pursue degrees in CS or CE. Women who do enter CS or CE programs are seen as social outcasts, plain, and unfeminine. As one female student said, "They think that I am a nerd. I am a geek. I am intimidating." Another said, "My folks see me as nerdy. They complain that I no longer have time for them, for the community. It has been hard for me and for them." Many Native American women also do not enter CS or CE programs because it is a white-male-dominated field, and so Native American women wishing to pursue CS or CE are caught between filial obligations and pervasive stereotypes.

FUTURE TRENDS

Changing the underrepresentation of Native American women in CS and CE will be difficult to accomplish. Some factors can be altered, but others are more challenging to modify because they are historically and culturally based. Gender bias will take some time to change, but ingrained cultural traditions among Native Americans are unlikely to transform. Therefore, one must focus on goals that are more likely to be achieved, such as providing access to resources and early exposure to computers.

When students were asked what could be done to attract more Native American women to the program, none of the suggestions were related to those cultural and historical issues that make Native American women choose not to pursue CS or CE degrees. Nevertheless, the majority of students mentioned program changes such as more female faculty instructors, classes for females only, and an alternative approach to learning. As one male student said, "It might encourage them to see more female professors in computer science because as far as I know, a majority of the CS department is males, mostly males." Another female student said, "More female instructors. I haven't had a female instructor yet." Students also suggested a number of support services such as scholarships, tutoring, and more computers.

Although these are good techniques to possibly change the underrepresentation of Native American women in CS and CE programs, one should not forget that historically, Native Americans have not had equal opportunities in education. The federal government and the education department must address issues of poverty and income inequality in order to indirectly improve Native Americans' access to technological resources, which will consequently bolster their interest in CS and CE programs.

CONCLUSION

Native American women face several issues that are different from Native American men who pursue degrees in CS or CE. Because they face factors pertaining to both race and gender, Native American women have a long way to go to achieve equality in higher education in CS or CE programs.

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KEY TERMS

Digital Divide: Refers to the socioeconomic gap between communities that have access to computers, the Internet, and computer-related technologies and those who do not.

Native American Cultural Traditions: Practices that include listening to elders; maintaining languages, ceremonies, and powwows; and having a self-perceived identity based on cultural traditions.

Native Americans: People officially classified as American Indians or Alaska Natives. They have origins in any of the original peoples of North and South America and maintain tribal affiliation or community attachment.

Two-Worlds Metaphor: The concept that Native Americans live in two worlds where there is cooperation vs. competition, group emphasis vs. individual emphasis, modesty vs. self-attention, the nonmaterialistic vs. the materialistic, harmony with nature vs. conquest over nature, the spiritual vs. the skeptical, and the aggressive vs. the passive.

Negotiating a Hegemonic Discourse of Computing

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INTRODUCTION

The number of women within computer sciences is low in Norway, as in other Western countries (Camp & Gürer, 2002). Research projects have documented that girls and women use the computer less and in other ways than boys and men (Håpnes & Rasmussen, 2003). Even though variations between women and between men also have been documented through research, a dualistic image of gender and ICT has dominated throughout the 1990s (Corneliussen, 2003b). Worries about the "gender gap" related to computers have resulted in a number of initiatives to include girls and women in the "information society," but in order to do this in a successful manner we need knowledge about what it means to be a man or a woman with a relation to computers. How do men and women construct their own relations to computing?

BACKGROUND

This article presents a study of how male and female computer students perceive gender as meaningful in relation to computing, and how they create their own relations to computing (Corneliussen, 2003a).[1]

Empirical Material

The empirical material of the project is based on a study of seven men and 21 women who were students in a programming course[2] at the Department of Humanistic Informatics at the University of Bergen. During a period of three months, they were observed while working in the computer lab, they answered weekly questions on e-mail, including questions about their relation to computing, and most of them were interviewed in groups.

Gender

Gender is a social construction that gives norms, rules, and guidelines for men and women. Gender is experienced and performed by men and women. Simone de Beauvoir's description of gender as "what we do about what the world does to us" (Moi, 1999, p. 72) illustrates how gender is both a structure that we meet in the world, as well as what we do about it. Thus, in the main section, we will first look at how men and women *perceive* that gender has a meaning related to computers, and second, how they find their own positions as computer users.

Discourse Theory

The most important theoretical perspective in the project is poststructuralist feminist theory, mainly inspired by the historian Joan W. Scott's insistence on studying gender as a discursive structure (Scott, 1988). The analytical tool applied in this project has been elaborated through this theoretical perspective, with a special focus on cultural production of meaning, inspired by Ernesto Laclau and Chantal Mouffe's theory of discourse (1985). Two important concepts in the following presentation are "discourse" and "subject position." The concept of discourse refers to a limited and temporarily fixed meaning within one particular area—like the discourse of computing. Subject position refers to a discursive point of identification within a discourse. While a discourse gives the guidelines for how to understand a phenomenon, the subject position gives guidelines for the individual, about expected or accepted behaviour. The individual can either associate with, negotiate or reject a subject position.

A HEGEMONIC DISCOURSE

Research has documented that there are differences in how men and women's relations to computing are perceived (Lagesen Berg, Gansmo, Hestflått, Lie, Nordli, & Sørensen, 2002). This is also evident in this project; all the informants shared a series of conceptions of how gender and computing were related. Together, these conceptions comprise a "hegemonic discourse" which seems to suppress other and alternative conceptions about gender and computing.

A central part of this hegemonic discourse is the different expectations towards men and women's relations to the computer. Men are expected to have interest, experience and knowledge about computers, while women are expected *not* to have the same interest, experience, and knowledge. Men and women are also expected to engage in different activities; men in activities associated with the technical machine and playing with the computer, while women are expected to use the computer for a specific purpose, and for a limited number of tasks.

The hegemonic discourse thus creates two distinct subject positions; one associated with the computer skilled man, and one associated with the less computer skilled woman. It is important to emphasize that a subject position is not a description of "real" men and women, but rather a description of the *expectations* towards men and women. People use these expectations towards themselves and towards others. This does not mean that the individual always is in harmony with the discourse, a point further demonstrated in the following chapter.

NEGOTIATING THE HEGEMONIC DISCOURSE

All the informants articulate their own individual ways to describe or position themselves in relation to computing. However, by looking at how these positions are articulated it is possible to point to a pattern of seven different *positioning strategies*. A starting point for all the different strategies is the hegemonic discourse, but they differ from each other with regard to the position they aim at, and thereby also with regard to the degree of harmony with the hegemonic discourse. We will first look at the three positioning strategies among the men, before we turn to the women's strategies.

MALE POSITIONING STRATEGIES

"Rooted in a Room for Men"

In the first positioning strategy, the men have "roots in a room for men." They can display harmony with the masculine subject position in the hegemonic discourse. They have experience with computers since childhood, and they have a lot of knowledge about computers. They conform to many of the expectations towards men in the hegemonic discourse; they have acquired their own experience "together with the boys" and "as one of the boys." A close relation between boys and computers is described as "natural," and one of them even thinks that "people almost expect that a boy studies computing." This group of men use the hegemonic discourse as a positive reference to their own relation to the computer.

"Aiming at a Room for Men"

The next group of men is also aiming at "a room for men," but they can not display the same harmony with the masculine subject position. That is, except for being men. They do not have very much experience or knowledge about computers prior to the computer course, but to acquire more knowledge seems to be something that they have wanted, and it gives them a more "proper" relation to the computer. Expectations about men's close relationship with the computer becomes a positive force in their own relation to the computer. One of them thinks that he learns tasks on the computer faster because of "the 'taken for granted' assumption that computers are something I can-handle, because I am a boy." Another one illustrates how he might be associated with the masculine subject position without really being qualified, and he is able to "hide" in this position. This positioning strategy clearly demonstrates how men have the *possibility* of being associated with computer competence and a positive relation to the computer purely based on gender.

"Outside a Room for Men"

In the last positioning strategy among the men, it is rather a *distance* from the masculine position, which is the goal. In order to achieve this distance it is the *lack* of computer competence that is being emphasized: "I have a PC with a sound card that does not work, that probably tells you how much I have acquired in that area." This man also "hid" his previous experience with computers, and even though the informants several times were confronted with questions about their experience, it was not until the end of the term he revealed that he had been studying computing before! In other words, men seem to need an active strategy in order to distance themselves from the expectations towards men, as if the masculine subject position too easily is activated by gender alone.

We have seen that the men have various ways of positioning themselves in relation to computers. However, the differences has less to do with introducing new elements to the masculine subject position than how well they conform to—or want to conform to—the masculine position. They illustrate that they have the possibility to use this position as a positive description of themselves, as a goal to reach for, or as a position to "hide in," as if gender alone is sufficient to activate the association to computer competence.

FEMALE POSITIONING STRATEGIES

"A Limited Room for Women"

The subject position associated with women in the hegemonic discourse is in various ways *limited* compared to the masculine position. The first strategy among the women aims at "a limited room for women," closely associated with the feminine subject position in the hegemonic discourse. The computer is associated with boys, and is described as "boring, masculine, and a bit nerdy." It is "obvious that the boys have the best understanding of the technical stuff." Female lecturers in computing are not seen as positive role models, but rather as "dissenters'" who have crossed a gendered line. These women use the expectations towards women's limited computer competence when they position themselves: "I don't understand any of that [computer programming], because I'm a woman!" A reference to gender is sufficient to activate the association to women's "limited" computer knowledge. These women do not challenge the hegemonic discourse, but rather use gender as an explanation of their own lack of computer knowledge.

"A More Open Room for Women"

The second positioning strategy among the women also emphasizes the difference between men and women's relations to computers. However, it differs from the previous strategy by aiming at "a more open room for women." These women describe themselves with a positive relation to computers, but still within certain limits compared to men. Many of them were sceptical in the start and attended the course with an idea about computers as boring and difficult to understand for women. However, as they learned more about computers they also "discovered" that they actually *could* learn, and that they actually *did* find computing enjoyable. Many of them also describe themselves as "addicted" after a short period at the computer course: "It feels like a new world has opened up to me ... and every day I think "How on earth is it possible to cope without knowing what I know today!??" It has to be a feeling close to something like going from being illiterate to being able to read ... I think that I have become addicted to the computer!!!" Many of the women in this group have become fascinated computer users, and they expressed pleasure about computer knowledge in general, as well as programming and other more technical related topics associated with men in the hegemonic discourse. An important part of their joy seems to be related to learning something within a field associated with men: "Maybe that is why I want to work with programming, because it is so masculine ... I feel sort of as if I were in a world that's a little bit forbidden." The former scepticism has turned to fascination. They are fascinated by being able to enter a field where women do not have a natural position, and they are about to create a more open and a more positive room for women within the discourse of computing.

"A Shared Room for Men and Women"

The third positioning strategy among the women aims at "a shared room" for both men and women. Gender is irrelevant for a person's abilities or possibilities within computing, these women claim. When they position themselves in a shared room, it is neither as identical to men nor as complementary, but rather as equals, with their own characteristics: "We are not men. We don't think as men. But we have values that are just as good as men's values." They have long experience with and knowledge about computers. However, they have also experienced being treated in accordance with the "limited expectations" towards women, and they need an active strategy in order to reject the hegemonic discourse: "No boy is allowed to tell me that I am not worth as much as he is, because then I'll tell him what I really think about that." This strategy is not about abolishing gender, but about establishing men and women as equals within computing. In addition, because the hegemonic discourse has a strong position, they need an active strategy to negotiate it; they need to "nag and make a fuss" to be heard.

"Woman in a Room for Men"

The fourth and last positioning strategy among the women aims at neither a room for women nor a shared room, but rather at "a room for men." These women use their experience with tasks and technical artefacts associated with men in order to position themselves in relation to computers: "Since I did not have a brother, my sister and I had to fill that 'gap' by learning practical tasks that traditionally often are performed by men." They describe the experience they have with masculine tasks as their advantage when they work with computers. By attending a computer course, they enter a masculine domain—like they have entered other masculine domains before.

CONCLUSION

We have seen how both men and women construct their own positions by negotiating the hegemonic discourse of computing. The positions constructed by the students are more varied than the gendered subject positions of the hegemonic discourse, and they illustrate the "individual's freedom" to negotiate the discourse. However, they also illustrate "the power of discourse." The hegemonic discourse creates certain limitations, and it establishes a norm which makes it easier to associate computer knowledge with men than with women.

The analysis illustrates what the informants "do about what the world does to them." The hegemonic discourse affects the different "spaces" that are available to men and women in relation to computing. Men can easily be associated with computers and computer knowledge purely based on gender. Women on the other hand meet a cultural perception of women as not competent in relation to computers. Thus, it is clear that men and women have different challenges to deal with in positioning themselves in relation to computing, and this requires more "hard work" for women than it does for men.

The tendency of women attending computer courses with a certain scepticism before they "realize" that they enjoy computing has also been found in other studies of computer students in Norway. Langsether claims that women who "dropped in" by accident or only chose one computer class to complete a grade at the University of Oslo found the study so interesting that they would have chosen a grade in computer science if they had not been "stuck" in their present path of study (Langsether, 2001). This indicates an unused potential for recruiting women to computer studies. One reason for women's hesitance seems to be the lack of cultural stories about women's pleasure in computing, which does not make it obvious for women that they would enjoy working with computers (Corneliussen, 2005). Another reason might be male enthusiasm or fascination with the technology, which has been documented as an important factor which "turns women off" and makes them distance themselves from the computer (Aune, 1996; Turkle, 1988). "Male enthusiast" has often acted as the norm for "proper" computer users, and this image undermines both differences among men as well as similarities between men and women.

FUTURE TRENDS

While stories about pleasure in computing seems to "stick" too well to men, the same stories do not seem to "stick to" women at all. It has often been claimed that we need positive role models for women within computing (Stuedahl & Braa, 1997). However, as we have seen here, a role model is not necessarily perceived as a *positive* role model if it does not have a "valid" cultural story to apply with. One of the big challenges for the future is to make available other subject positions than the hegemonic discourse's male and female positions, in particular to make visible cultural stories about women's pleasure in computing (Corneliussen, 2005; Nordli, 2003).

We often refer to "myths" about gender and computing, often seen as "unsettled questions" or "myths we have to reject." That might be true, but it is also true that we need to take these myths seriously—not as myths meaning something which is not true, but as cultural stories which contribute to the construction of gender in computing. The fact that these stories are not always in line with the "reality," does not make them less "real"—they still exist, and these cultural stories have real effects when they are perceived as a valid frame of reference for men and women trying to find their own position related to computers and to make themselves culturally understandable as computer users.

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KEY TERMS

Articulation: Every social practise which contributes to putting meaningful elements in new relations to each other in such a way that their meaning is altered can be seen as an articulation (Laclau & Mouffe, 1985).

Discourse: Within discourse theory, a discourse is seen as a limited and temporarily fixed meaning within one particular area. A discourse is perceived as a fixed objectivity through "homogenisation of an interior" and "exclusion of an exterior."

Discourse Theory: Discourse theory as it originally is articulated by the political philosophers Ernesto Laclau and Chantal Mouffe (Laclau & Mouffe, 1985) is one among a wide variety of discourse analytical propositions. Its focus is on politics and the construction of meaning.

Gender: In a poststructuralist perspective, gender is seen as a discursive category based on "perceived differences between the sexes" (Scott, 1988, p. 42). Gender is a historical and social construction that both explains and provides norms, rules, and guidelines for men and women.

Positioning Strategy: The strategy employed to create an individual position in relation to the hegemonic discourse of computing.

Subject Position: In a discourse theoretical perspective, a subject position is a discursive point of identification within a discourse. The subject position gives guidelines for the individual.

ENDNOTES

1 See also Corneliussen, 2002 for discussions about theory and method, and Corneliussen, 2003c for a presentation of the male informants.

2 I was also teaching in this group, and my "double" position is discussed in Corneliussen, 2002.

Online Life and Gender Dynamics

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INTRODUCTION

The study of gendered interaction online grows out of studies of gendered interaction off-line and will probably be found to be a cultural variable changing with off-line gender behaviour in different social groupings. However, this does not dispose of the issues of gender's influences on online behaviour, or of whether gender behaviour online is transformed in relation to behaviour off-line.

The relevance of gender may vary in different contexts: with class, religion, place, proportions, type of online forum, topic of discussion, and so on. These contexts could overwhelm gender identities existing outside them and their effects need to be investigated. Power ratios between people of various genders may also vary within different contexts and cannot be assumed in advance. Gender both enables and restricts behaviour; it is neither merely positive nor merely negative.

In the West (at least), gender seems to be constantly in flux and interrogation, and it is not surprising if such interrogations and uncertainties occur online. Despite this interrogation, gender in off-line life seems to be treated as an essential part of a person's being or identity, and it guides reaction to others.

BACKGROUND

History and Attitudes to Computers and the Internet

Gender can influence the ways people interact with computers even before they go online. Studies of education consistently show boys being given preference accessing computers by parents and teachers (Rajagopal & Bojin, 2003). Female students may feel as competent as males in using computers while being more negative about their own involvement with computers (Herring, 1993; Sophia, 1993).

Turkle (1984) suggests that different social groups bring differing modes of interaction to computers and, as a result, find them more or less satisfying. Thus, women might attempt to negotiate with computers, while men might try and control them . Furthermore, computers are usually posited as nonemotional (Turkle), and this supposed lack might induce some people (particularly women) to find interacting with computers less satisfactory than it is for people whose aims are primarily "results oriented" (Sophia, 1993, pp. 16-17). Women, as the default carriers of emotions and performers of emotional labour in the West (Cheal, 1988; Erickson, 2005), could define themselves in opposition to computers, particularly when their usage of them was relatively uncommon. Similarly, rather than deal with the complexities of real humans, the definitively masculine or nonemotional male might flee to computers, particularly if his masculine definition is not adequate in other areas (Turkle, 1984). However, relevant gender conventions may change; at one time, programming was considered a branch of secretarial work and handled by women (Wacjman, 1991).

As the Internet was initially largely constructed and used by males, the social customs developed may well have made it harder for women to use or approach it. Such effects might have altered over time, especially given the increase of women using computers and the Internet. However, detailed historical research of such changes is rare.

Type of Forum

Different types of online forums (i.e., mailing list, MOO [MUD (multiuser domain) object oriented], newsgroup, chat room, IRC [Internet relay chat] channel, blog) differ in the ways they structure communication and allow response or the use of power, and enable the ways in which gender can be an identifier. Some forums encourage people to play characters, or avatars, and some encourage people to use their own names. Large MOOs tend to be governed by committee, whereas mailing lists tend to be governed by debate (both on- and off-list) and the decision of the moderator. Newsgroups tend to be governed by argument, confrontation, and people withdrawing when they have had enough. As a result of these structures and organisations, different forums produce different types of experiences and behaviour (Marshall, 2004). Research in one kind of forum may produce different kinds of results than research in other types of forums. For example, anonymity, gender ambiguity, or cross-gender impersonation seem much less pronounced on mailing lists than on MOOs or IRC.

Presence is ambiguous online with people only appearing present when they type, therefore it may be more common for males on MOOs to engage women in conversation and try and gain their opinions to make sure they are there than it is off-line where the presence of a listener is so much more marked.

Communication Patterns

Susan Herring has carried out the most extensive studies of online interaction showing the replication of off-line communication patterns that tend to silence women or render women's talk marginal. In her early study of the discussion lists LINGUIST and Megabyte University, Herring (1993) found that women participated "at a rate that is significantly lower than that corresponding to their numerical representation." According to her research, "[w]omen constitute 36% of LINGUIST and 42% of MBU subscribers." Yet in a discussion on sexism, women constituted only 30% of posters. In more neutral discussions, only 16% of posters were women.

On three occasions, Herring (1993) found that "women's rate of posting increased gradually to where it equalled 50% of the contributions for a period of one or two days." Not enough information is given to discover whether this resulted from an increase in the number of women posting, or whether a few women became more active, or whether the number of men posting had declined. However, the reaction "was virtually identical in all three cases: a handful of men wrote in to decry the discussion, and several threatened to cancel their subscription to the list." This certainly implies that some men could not cope with such a visible, or argumentative, female presence and did their best to stop it within the structural possibilities of mailing-list life.

Herring (1993) also claims there are distinctive gendered styles of interaction that reflect expectations in the off-line world. In order of decreasing magnitude, she found that men discussed issues, provided information, made queries, and wrote about personal things, while women wrote about personal things, made queries, then discussed issues, and least of all provided information. Herring also found that "the messages contributed by women are shorter ... a very long message invariably indicates that the sender is male," and that "messages posted by women consistently received fewer average responses than those posted by men ... [and] topics initiated by women are less often taken up as topics of discussion by the group as a whole."

This research suggests that women, and women's interests, were marginalised in the public activity of these groups, and that male dominance was replicated even without use of physical force and in an environment in which gender is claimed not to matter. However, when Herring (1994) looked at lists focused on "traditionally 'feminized' disciplines ... [she] found women holding forth in an amount consistent with their numerical presence on the list."

Herring did not investigate, except briefly, the ongoing interaction of male and female subjects; each utterance seems to be taken in statistical isolation. There is no investigation of overall trends or variation, or even of the ways in which people interact to coproduce the ambience of the list or recognise and reinforce gender.

Although many of Herring's results have been replicated (Herring, 2000), it is common for some parts not to be (Hatt, 1998; Savicki, Kelley, & Oesterreich, 1999; Savicki, Lingenfalter, & Kelley, 1996; Vaughn Trías, 1999), suggesting there may be other variables involved. It is only recently that Herring (2000) has suggested that different modes of Internet communication might have an effect. Engagement with such issues requires intensive fieldwork, rather than brief visits or abstract samples, because fieldwork better enables the researcher to know individuals and place them amongst local and wider social dynamics.

Flaming and Harassment

It is frequently alleged that women are less inclined to flame and argue than men (c.f. Baym, 1995), and are thus often driven out of online groups. Herring (1994) writes, "the simple fact of the matter is that it is virtually only men who flame" because male communication ethics "can be evoked to justify flaming." However, in her research, both men and women state that they do not particularly like flaming, and there is no indication of how she came to rate an e-mail as a flame. In practice, flaming tends to be seen as something that other people do, with people often regarding something they, or their group, have posted as not a flame even when others strongly identify it as one.

Therefore, this proposition about women and flames is hard to check, even though it is widely believed and would be widely expected due to offline behaviours and beliefs. However, some researchers have suggested it is not the case. Witmer and Katzman (1998) concluded their statistical research on "newsgroups and special interest groups on the Internet and CompuServe" by writing, "The data do not support the ... hypothesis that men use more challenging language and flame more often than women" (p. 7). My own research suggested that women can get as involved in flame war as men (Marshall, 2004), and research at a girls' school in Melbourne was reported to show that girls had taken to the Internet to bully, exclude, and intimidate each other (Jones, 1998). Nevertheless, it is probably true that women, generally, do not engage in flame wars with men, and tend to avoid places where such events are common.

There are also well-documented stories about continual harassment of women by men demanding or requesting Netsex (Brail, 1996; Gilbert, 1996; Hall, 1996; Smith, McLaughlin, & Osborne, 1998; Spender, 1995). Campbell (1994) describes his experiences when he used a woman's account to get free access to a BBS. Immediately on logging on, he received 31 requests from one male whose message descriptions repeatedly included *sex* and with whom he had had no prior contact. Another man sent him his phone number. People who were initially helpful ended up wanting Netsex as recompense and so on. Another less direct form of harassment is that people presenting themselves as female on MOOs are often challenged to prove their gender (La Pin & Bharadwaj, 1998). This could lead to women downplaying, or neutralising, their gender and thus to the suppression of specifically gendered interests, irrespective of whether harassment is an attempt by some males to maintain their part of the Net as a male domain.

Harassment is also reputed to occur through the large number of sex jokes or obscenities being used. However, in at least one case in my research, sexual one-liners were used by women in an attempt to restore commonality after a group was riven by political disagreement during the lead up to the Iraq war. Because of its effects, this is an issue that needs more direct research and clearly will affect people's ease online.

Lowering flame and harassment while providing a safe place to speak has often been one of the reasons given for the founding of women-only forums. However, it is not always clear if this result arises because of the involvement of women alone, or because of strict control by the moderator (Herring, 2000). In some cases, it seems that women may be thrown off these lists for not behaving in an appropriately female way, as recorded in Hall's (1996) account of the SAPPHO list. The ideology of femininity becomes self-reinforcing by excluding those who do conform. Violence and discrimination can manifest in many ways other than through overt aggression.

Gender Anonymity

Supposed gender anonymity can be assumed to give people more freedom, but it can also be used to impose restrictions. I have observed cases in which people (usually male) react to challenges that they are behaving in an exclusionary male way by declaring that the challengers do not know what gender they really are even if they had been signing their names as male and had been recognised as male. Such tactics seem to attempt to degender male behaviour and imply that objections to it are sexist, further disempowering women.

Despite the alleged commonness of gender anonymity, the categorisation of people is one of the ways in which participants decide what kind of messages others are emitting, and whether they are likely to have much in common. As the importance of being able to categorise others often depends on what we are trying to achieve, researchers can get some idea of the importance of particular categories in different situations by investigating how often these categories are requested. People usually agree that the most popular category questions for Westerners online have to do with gender, age, and location. The question of "What do you do?" that locates class, prosperity, and probable education is far less common online than off (Ten Have, 2000). Locating gender seems especially important when people are seeking some level of private intimacy or emotional support.

Public and Private

There is often a level of ambiguity and uncertainty about what constitutes public and private domains online, and these may be associated with gender roles.

The ideas of public and private are ambiguous in much non-Internet space as well. The categories themselves may be contested, fluid, and ambiguous to start with. Saying that one part of the Internet is really public and another is really private may be possible on occasions, but most situations are not clearly marked and cannot be marked. Deciding what is what, or how the categories are deployed, is an ethnographic question, not one that can be decided in advance.

However, on mailing lists there are basically two forms of sociality: on-list and off-list. Off-list exchanges tend to be dyadic, approximating and suggesting the ideal Western English-speaking world the private intimacy of the couple. If this distinction between private (or intimate) and public (or communal) comes easily to Westerners, then it is worth investigating whether the traditional association of women with the intimate or off-list sphere and men with the public and on-list sphere has any effect upon behaviour and modes of exchange.

It has frequently been remarked that intimacy can appear to be established relatively quickly between relative strangers online who risk little in letting a distant person in on their secrets. If, as Cheal (1988) claims, gender is the prime way Western people establish intimacy, and this almost always involves women, we could expect that relationships directed at the private or off-list dyadic sphere will be influenced by, or even depend upon, gender conventions. Establishing that at least one of the dyad is a woman allows closeness to manifest more easily. If it is common that maleness is identified with aggression and flaming, and that, in contrast, women are identified with more harmonious interaction, then such identifications probably increase the importance of gender in off-list exchange.

Non-Western Gender Behaviour

There are still relatively few accounts of online gendered behaviour from non-Western cultures. Miller and Slater's (2000) study of Internet use amongst people from Trinidad shows that people use the Internet for making friends (particularly of the other sex), to reestablish patterns of mother-daughter support when children are overseas, and to engage in the semisexual public communication style known as "liming," which the authors write might be considered sexist or racist in the countries of residence. People from Trinidad also remark on the speed in which intimacy can appear to be achieved online. This lack of studies can be expected to be filled very shortly.

FUTURE TRENDS AND CONCLUSION

Currently, the categorisation of either the self or others is unlikely to derive from the membership of Internet-based groups alone as there are few environments in which different online groups, or groups formed elsewhere online, interact with each other. Therefore, most such categorisation is going to involve off-line categories. It is possible that the more marked these off-line categories are in their being embedded in society, the more likely they will be exaggerated online, and the more these categories may overpower those senses of group membership that have no reinforcement other than in participation in the online group. This appears to be the case with both gender and political divisions, and it seems unlikely to change in the foreseeable future. There is not much evidence for the common Western propositions that the online world is separate from the off-line world, or that gender is unimportant online.

Not only have the numbers of people online been increasing rapidly, but the proportion of women and men online has been approaching equality in the Western English-speaking world. That it has not in other parts of the world indicates that off-line cultural factors are still important here. Twenty years ago, middle-class women could exist without much interaction with computers; today, this is much more difficult. It means that much research on gender has the problem of becoming history before it gets published.

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KEY TERMS

Avatar: A graphic representation of a person's character in a multiplayer computer game or environment. By extension, it is often used to refer to the character itself.

Blog: A blog is basically a diary on the World Wide Web. Blogs generally link to other blogs, perhaps to indicate common interests or that the authors read each other's on occasions. Some blogs allow readers to post comments on the entries.

Chat Room: An Internet site that "contains" the participants in a real-time interaction. Those within the chat room can read what each other is typing. People enter the room to participate and can be banned from it. Some suppliers may allow people to temporarily, or permanently, set up their own rooms.

IRC (Internet Relay Chat): A way of communicating with others on the Internet. It requires that users have a software client allowing them to connect. An IRC channel is something like a chat room, except that it is not necessarily based on a particular computer. The person in charge of the channel has the ability to throw participants off, and to hand this right to others.

Mailing List: A way of communicating over the Internet as a group. The list is set up on a particular computer, and accepted mail written to that list is delivered to all the people registered with that list. Usually a person will be the list owner and is responsible for running the list. He or she will often be the moderator, be a person who participates in the list, and have the power to state the list rules and to remove people from the list.

MOO (MUD Object Oriented): A way of communicating with others over the Internet. It could be thought of as an interconnected set of spaces set up on a single computer. The term is here being used to cover the whole family of such setups descended from the original MUDs, a MUD being a multiuser dungeon or multiuser domain. A person using one of these Internet forums logs in and plays a specific named character, usually with a text description, and can write or accumulate programmed objects, rooms, or devices that add to the environment. This means that he or she has some prop support for playing the character.

Netsex: Sexual activity carried out over an Internet communication channel, usually by exchanging written descriptions of sexual behaviour.

Newsgroup: A way of communicating over the Internet. A newsgroup is generally a distributed form of communication resembling a message board but not sited on a particular computer. As such, it is notoriously difficult to exclude mails from newsgroups and many were rendered unreadable by the number of advertising posts received. The software used to read newsgroups varies, but they commonly used to organise groups by threads.

Online Life and Gender Vagueness and Impersonation

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INTRODUCTION

Impersonation and Gender Categories

Gender is not always immediately obvious online and this has excited interest from early on (e.g., Bruckman, 1993; Curtis, 1997). Sometimes, people have drawn extreme conclusions from this vagueness. For example, Mark Poster (1997) suggests that "one may experience directly the opposite gender by assuming it and enacting it in conversations" (p. 223). McRae (1996) writes, "mind and body, female and male, gay and straight, don't seem to be such natural oppositions anymore ... The reason for this is simple: in virtual reality, you are whoever you say you are" (p. 245). Such statements imply that gender is simply a voluntary and unconstrained conscious performance. Other writers have concluded that such identity vagueness allows, or enhances, the formation of postmodern decentred or multiple selves (Kolko & Reid, 1998; Turkle, 1995).

These arguments suggest that, when online, people are free of off-line conventions, restrictions, and power dynamics, and can experience hidden aspects of themselves, or create themselves, through an act of will and performance. Frequently, these positions are surrounded by a conflicting moral discourse, either suggesting that the Internet promotes freedom and true self-expression, or that it promotes bad faith and betrayal.

However, easy voluntarism may not be common in practise. Although it is possible that people may present new identities, the categories they use and present within can remain unchallenged and may even intensify. After her praise of voluntarism, McRae (1996) points out that if someone plays a woman and wants to "attract partners as 'female' [they] must craft a description within the realm of what is considered attractive" (p. 250). Schaap (1999) likewise remarks on the relatively "strict rules on what constitutes a convincing female character and what a convincing male character." So, although the gender of the person online may not match their gender off-line, the gender they choose usually exaggerates the conventions of attractive or good gender construction. As Kendall (1996) writes, "choosing one gender or another does nothing to change the expectations attached to particular gender identifications" (p. 217). Even if gender is simply a matter of performance, people will not experience life as the other gender or class does because they have to indicate which category they are impersonating via conventions, and thus tend to experience cliché, and reaction to cliché, rather than normal complexity.

On MOOs (MUD [multiuser domain] object oriented), where Netsex can be important in reducing the ambiguities of presence and sustaining relationships, most women and men are adorned with an excess of the symbolism and roles of the gender and sexual discourse they participate within, and this may reinforce ideals of gender difference (Marshall, 2003). This seems to be the case even when people portray themselves as nonhuman. As an example of this supposed variance, McRae (1996) quotes a player on a kind of MOO in which people present themselves as anthropomorphic animals, saying there is a form of sex in which "the submissive partner is eaten at climax ... [B]ears and wolves are usually dominant. Foxes are sorta generally lecherous. Elves are sexless and annoyingly clever. Small animals are often very submissive" (p. 248). Even here, the relationship of size, bulk, aggression, and strength to dominance is not far from conventional constructions of male and female.

This requirement to indicate gender by conventional referents may also lead people to portray their off-line gender in conventional terms as well. Clark (1998) notes this clichéd gender emphasis in her study of online teenage dating, while Herring (2000) writes that she "found that nearly 90% of all gendered behavior in six IRC [Internet relay chat] channels indexed maleness and femaleness in traditional, even stereotyped ways; instances of gender switching constituted less than half of the remaining 10%." Conventions can also provide debate on women-only groups, where people can only be identified as female by their feminine behaviour unless they are checked by known links off-line.

As it is possible to ignore the gender of those who contradict our expectations of gender, those expectations may grow stronger for not being challenged.

BACKGROUND

Betrayal

In tandem with ideas of identity flexibility is the narrative that online life is full of cross-gender impersonation, and that as a result, interactions are potentially hedged with betrayal and disillusion (cf. Kolko & Reid, 1998).

These common narratives apparently contradict each other. If gender is so unimportant to online life, then why is impersonation such a source of anxiety and distress? The problem arises partly because life online is not separated from life off-line, and people commonly act as if the online needs verification by the off-line, where gender is important to the ways that people relate and the expectations people have of each other. These verification patterns are usually asymmetric; the off-line, which is more private or hidden, will usually be assumed to be true if it contradicts the online or more public sphere.

In general, it is the impersonation of women by men that causes anxiety, not the other way round, irrespective of whether the impersonation occurs amongst males or females, and this needs to be explained. Innocence of intention is rarely presumed. In a famous case, Van Gelder (1996) describes a male who was once mistaken for a woman by another woman who was "open in a way that stunned him." He then deliberately embraced a female persona, became intimate with many women, and helped them with their problems. When this was discovered, some of the women involved considered it violative. Van Gelder asks "why a man has to put on electronic drag to experience intimacy, trust and sharing" (p. 546). However, this performer had constructed an elaborate fictional biography and engaged in Netsex with others before marrying an equally fictional off-line husband. Eventually the man, as himself, tried to make friends with his character's friends but failed. After the truth came out, only a few friendships carried over, with at least some of those who remained friends trying to see the similarities between the fiction and the persona (Stone, 1995). The case indicates that people may not wish to engage in intimate contact with a person who is not as they present themselves, contrary to the voluntarist or postmodernist argument.

Conventions of Identification

People online seem largely confident that they can identify a person's real off-line gender by that person's habits or styles of conversation. These identifiers are derived from customs based on off-line gender expectations. One such expectation is that women tend to use lots of emoticons to indicate or express emotional states as Western English-speaking female discourse is supposed to be more emotional, or deferential, than that of males, and some research has found greater emoticon use to occur (Witmer & Katzman, 1998). Aggressive or argumentative behaviour is usually considered a mark of masculinity.

Other methods of divining gender include discussing the kinds of things an off-line person of that gender could be expected to know. This often translates into some kind of product knowledge, such as panty-hose or ring sizes, for example (Suler, 1999), and does not always translate well across different cultures. Some reports indicate that people will read books on gender differences in speech use, either to improve their ability to identify a person's gender or to impersonate the other gender better (Wright, 2000).

When people apply gender-neutral pronouns to themselves, for example, in spivak, other people will not generally assume that they really are gender neutral or that their gender is a matter for privacy, and they will often try and find out what their real gender is (Kendall, 1996). Some researchers have reported that people who maintain vagueness about their real gender are "generally 'dropped' from the interaction" (O'Brien, 1999, p. 90). So, there can be punishment for being vague, as well as for being found out.

In general, people work hard at detecting the gender of others, and it is worthwhile to ask what kind of circumstances lead people to become concerned.

Frequency and Place

People generally assume that cross-gender impersonation is common. Elias (1997) reports that unnamed "experts estimate two out of three 'women' in many chat rooms, particularly the sex-oriented ones, are men" (Curtis, 1996).

It seems that impersonation occurs more frequently in MOOs, IRC, and chat rooms where people are identified by a character or avatar name than it does on mailing lists or in newsgroups where they are identified by e-mail addresses. Even here, it probably varies with the situation. It is perhaps most common in gaming, when differently gendered characters can have different kinds of, usually clichéd, advantages that are either built into the game, or arise from social factors, such as female characters receiving more help from male characters at lower levels, something that may not always be maintained at higher levels.

Herring (2000) writes that "claims of widespread gender anonymity have not been supported by research on online interaction." A major survey of online sex behaviour reported that "[o]nly 5% of the sample indicated pretending to be a different gender, and most of them (4%) said that they do so only occasionally" (Cooper, Scherer, Boies, & Gordon, 1999). Even on MOOs where impersonation might be expected to be common, Deuel (1996) writes, "Evidence suggests that most MOO participants represent themselves as their true gender or as neuter, with only a small percentage of players actually attempting to conceal or intentionally misrepresent their gender" (p. 133).

Survey data and conversations gathered during the author's own fieldwork suggested that gender impersonation did not have a widespread, long-term appeal. This is not to deny that some people may do it frequently, but to suggest that most people do not do it deliberately for prolonged periods of time. Sometimes, it does arise that the gender of a person can cause surprise. In my fieldwork site, the gender of one person was frequently mistaken, probably because of his gentleness, his responsiveness, and his habit of typing emotions (e.g., *smile*), but he never masqueraded as female or as genderless, and indeed was commonly explicit about his gender. This implies that, for some people, reading the conventions of gender overrode his remarks on the subject. During my fieldwork, no one ever expressed surprise at discovering someone they thought was male was female.

There are some situations in which gender may be played down by people. For example, on a specially set-up list for 75 college students, "women tended to mask their gender with their pseudonym choice while males did not" (Jaffe, Lee, Huang, & Oshagan, 1995). This may be because it saved them from inequitable patterns of gendered interaction and harassment. However, it also destroys the capacity for a politics of gender.

Authenticity

If it is so rare, and people are so confident they can detect differences, why does gender impersonation cause so much anxiety?

It suggests that the true off-line gender of the other person is important for framing communication. It adds background that enables text to be read, suggests the possible styles of communication that can be engaged in, and enables people to know what is appropriate to say. Contexts that increase this importance should be investigated.

From the stories told, gender importance increases when the interaction has been dyadic, when intimacy has been invoked, and when the supposedly female person is found to be male. This arises as in the off-line world, most (nonhomosexual) intimate, emotional, or open relationships involve at least one woman (Cheal, 1988). Male bonding has become almost suspect, particularly if it involves intimacy. Finding out that a person you were intimate with was not female when you thought so almost automatically changes the relationship from the realm of intimate and private into a kind of public betrayal. Our private role and its vulnerabilities have broken into the public male domain.

Thus, people try to find out the truth about others with whom they interact intimately online. One of the few ways in which authenticity and truth can be shown is by reference to the body and its inchoate, underlying feeling nature. Thus, it is often the case

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that aggression is taken as more real, or as revealing more, than politeness, which is supposedly more distant from this primal nature. Not everyone has to follow the full problematics of authenticity, but it seems common, and people strive to find out the reality of others by reference to off-line or bodily factors, of which gender is one of the most important (Marshall, 2004).

Although people often claim that gender constructions should not detract from expressions of the authentic self, in practise, gender is a prime way of categorising others, determining what to expect from them, and allowing the interpretation of authenticity, so it can rarely be discarded, particularly when discourse shifts into the private or intimate realm.

The use of authenticity also emerges as it is common for people to see the use of fake gender as expressing some repressed, and therefore true, homosexuality. This is also a convention; homosexuality may have nothing to do with gender ambiguity. Curtis (1996) writes, “Some MUD players have suggested to me that such transvestite flirts are perhaps acting out their own (latent or otherwise) homosexual urges or fantasies” (p. 128). In an interview, Cooper (1996) states,

> *I’d rather see [impersonators] struggle with their sexual identity issues directly and get some clarification ... I’d rather they decide that they are gay or transsexual or transgendered and resolve their feelings one way or another so that they could become comfortable sharing their sexuality with a live partner.*

Such views imply that gender impersonation is a psychological problem rather than a sociological phenomenon, and that the Internet allows people the delusion of escaping from their problems rather than facing them.

Performance

As should be clear, there is a large stream of either positive or negative constructivism popularly associated with Internet behaviour. Perhaps this is similar to U.S. tradition that holds that positive thinking can change your being, or

> *[t]hat freedom of choice includes everything: profession, family, religion, sexual preference, and above all the ability to change any of the options (in effect to rewrite one’s life story) at almost any time. Admittedly, for many Americans this ultimate freedom is not available. But the ideal remains, and it is the ideal of a network culture.* (Bolter, 1991, p. 233)

However, these ideas are more usually anchored in mentions of Foucault or Judith Butler than in references to Norman Vincent Peale. From the evidence, it is possible to be dubious as to the amount of reconstruction that occurs, and it seems probable that rather than expressing multiple selves, people tend to use authenticity and the idea of a hidden true self as their moral and interpretive guide to self and others. Finding out about the true self of the other becomes a problem that must be solved rather than a vagueness to be celebrated (Slater, 1998).

Following Butler (1990), gender may be considered as a performance and thus unstable. However, a performance can also be a manifestation of something held to be authentic and essentially true; it should not automatically imply fictiveness or liberated play. There is no reason why a performance should necessarily challenge convention. An actor or a musician is not entirely free to do as he or she chooses; even if there is no script or score, he or she must follow some kind of convention for the performance to achieve results. The same is true, as argued earlier, for gender.

Ideas around performance also seem confused in that a performative statement that creates what it announces (i.e., “You are now man and wife”) is officially not a performance, and this is precisely because a known performance is taken as not real. The fact that movies may feature weddings does not undermine the idea of weddings themselves.

FUTURE TRENDS AND CONCLUSION

It is hard to predict the future, but it is probable that gender will continue to be of importance in online identification, that people will persist in trying to discover the authentic gender identities of those with whom they are becoming close, and that gender impersonation will still only have limited fields and places of application online, just as it does off-line.

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KEY TERMS

Authenticity: The convention whereby it is assumed that there is an underlying truth to people's actions, that they should, ideally, display this truth, and that this truth is uncoverable (see Taylor, 1991; Trilling, 1974).

Avatar: A graphic representation of a person's character in a multiplayer computer game or environment. The term is often used to refer to the character itself.

Emoticon: An icon depicting emotions. The term is usually used to refer to what are called smileys, which are glyphs that are read sideways. Thus, :-) represents the eyes, nose, and mouth of a face on its side. The form most usually deployed loses the nose, becoming :). Often, the term is extended to cover other textual expressions of emotion or bodily states, such as <OWWWW!!!>.

IRC (Internet Relay Chat): A way of communicating with others on the Internet. It requires that users have a software client that allows them to connect. An IRC channel is something like a chat room except that it is not necessarily based on a particular computer and is not controlled by people who are not part of the group.

Mailing List: A way of communicating over the Internet as a group. The list is set up on a particular computer, and accepted mail written to that list is delivered to all the people registered with that list. Communication tends to be asynchronous, and people will typically receive communications amidst the rest of their e-mail.

MOO (MUD Object Oriented): A way of communicating with others over the Internet. It could be thought of as an interconnected set of spaces set up on a single computer. Communication tends to be synchronous. The term is here being used to cover the whole family of such setups descended from the original MUDs, where a MUD is a multiuser dungeon or multiuser domain. A person using one of these Internet forums logs in and plays a specific named character, usually with a text description, and can write or accumulate programmed objects, rooms, or devices, which add to the environment. This means that he or she has some prop support for playing the character.

Netsex: Sexual activity carried out over an Internet communication channel, usually by exchanging written descriptions of sexual behaviour.

Newsgroup: A way of communicating over the Internet. A newsgroup is generally a distributed form of communication resembling a message board but not sited on a particular computer. As such, it is generally difficult to exclude mails from newsgroups, and many were rendered unreadable by the number of advertising posts received. The software used to read newsgroups varies, but they commonly used to organise the group by threads.

Spivak: Speaking spivak means a person uses the pronouns *e*, *em*, *eir*, *eirs*, and *eirself* instead of *I*, *he* or *she*, *hers* or *his*, and so forth. In some forums, this can be set into the program so that the conversion occurs automatically. For the origins of spivak on LambdaMOO, see Danet (1998).

Synchronous/Asynchronous: Terms used to describe the time factor of messages. A conversation is synchronous when it is conducted with the text and response being relatively close together. A conversation that is asynchronous is more likely to resemble an exchange of letters as the text and its response are separated in time.

Online Life and Netsex or Cybersex

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INTRODUCTION

Netsex, or cybersex, may be thought of as the mutual textual simulation, or narration, of sexual activity between people online. Branwyn (1993, p. 786) divides Netsex into three different types. First is that in which people "describe and embellish real-world circumstances" such as touching themselves, taking their clothes off, and so on. They may or may not be performing these actions, but probably not if they are typing reasonably steadily. The second type involves "a pure fantasy scenario" in which people jointly create a story with relatively coherent expectations. This can be performed before an audience. The third type involves one party giving instructions to another who supposedly performs them. These techniques involve textual references to sexually charged notions of gender (anatomy, actions, clothing, and so on), which are frequently exaggerated to fit the story.

It is now possible to transmit real-time video pictures from a camera attached to a person's computer, and this may also be used for Netsex. However, people often express ambivalence about this, perhaps because it emphasises the distance between people, is not as mutually intense, or because it increases possible disjunctions. The disruption of expectations of narrative in Netsex is often a source of online humour. A final, often mentioned, but currently fictional form of Netsex is virtual teledildonics, in which a complete sensory field is simulated via electronics.

BACKGROUND

Prevalence of Netsex

Netsex is reputedly quite common. Hamman (1997) states that in his experience, about half of all AOL (America Online) chat rooms "have sex related names," and he believes that a large number of AOL users, if not the majority of them, "have at least experimented with having cybersex" (Hamman, 1996). Sannicolas (1997) looked at the chat rooms open on the Microsoft Network (MSN) over a 2-week period and discovered that in the nonregistered rooms, "an average of 98 (21.2%) listed sexual topics." A survey posted to an MSN notice board gained over 9,000 responses and revealed that 45% of respondents claimed to spend over an hour a week on "sexually related activities," with more than 7% reporting they spent 11 or more hours a week on those activities (Cooper, Scherer, Boies, & Gordon, 1999).

Netsex shades into online dating and into using the Internet to meet potential partners (Elias, 1997; Olson, 1999-2000). Obviously, the intensity of any person's use of the Internet for sexual or romantic purposes may vary over their life online.

Explanations for Netsex

Netsex has been explained in terms of sex drive, male dominance, difficulties in finding partners, psychoanalytic projection, addiction, and liberation, as will be described below.

Common motives are that technological development is driven by sex, people will use new technology for sex, and the easier the technology is to use, then the quicker it will be embraced for sex (Dery, 1996). Such theories seem exaggerated, assume a ubiquity and uniformity of sex drives, and have little to do with the actual uses or forms of Netsex as actually employed between people.

Sometimes the prevalence of sex online is explained as the way the Net is marked as a male domain. In this view, women are excluded and harassed by sex talk, and by males trying to pick them up or render them sexual beings alone. Sherman (1995) has even suggested that the publicity given to harassment online was a deliberate attempt on the part of the male-controlled media to frighten women away from the Net. However, harassment is not uncommon for women on the Internet, particularly in chat environments (see Brail, 1997; Branwyn, 1993), and males can also feel harassed by female demands for online sex (Tober, 1995). One of the most famous tales of online life is Julian Dibbell's "A Rape in Cyberspace" (1999), in which the takeover of a woman's avatar and her sense of self is described and given the almost mythic function of originating formal social control and civilisation.

However, online groups may disapprove of sexual harassment and clearly distinguish it from Netsex, and it seems that women participate in Netsex with as much enthusiasm or ambiguity as men (Marshall, 2003). Given this, it is necessary to separate Netsex, a usually private, mutual activity, from the use of sex talk and harassment in public.

Netsex and online pairing is often explained by claiming that people find it extremely difficult to meet potential sexual partners in modern Western society. Albright and Conran (n.d.) write, "Online communities accelerate the expansion of opportunities for relationships begun by personals, video dating, and telephone chat line," while Hamman (1997) claims that a "lot of these people are isolated, either geographically [or] socially." In this view, Netsex can be seen as part of wider social processes that have resulted in increasing isolation, with the suggestion that pairing and sexuality are extremely important in the construction of gender and self-identity (particularly as sexual activity is usually gendered), and in ensuring survival in the contemporary world.

In slight contradiction to this theory of meeting potential partners, it seems that many such affairs involve people who are married and claim their marriages are happy. Over half the cyberromance stories commented upon by Vixen (n.d.) involved at least one married person. Olson (1999-2000) claims that in his survey, despite almost half his respondents claiming to have been in love online and one third of them dating people met online, over 70% claimed to be married (Olson, 1999-2000). The Internet can be seen as a safe place to have affairs and thus even to save marriages as a result (Ben-Ze'ev, 2004).

The prevalence and intensity of sex online can be explained by the supposed blankness of the computer screen, psychoanalytic projection or transference, and the easy activation of fantasy (Albright & Conran, n.d.; Bednarcyk, 1994; Elias, 1997; Hamman, n.d.; Odzer, 1997; Vixen, n.d.). This explanation can be formulated in terms of escape as when Hering (1994) writes, "Simply stated, the internet is a place where men, women, and children can exercise their fantasies, as well as escape the realities of their boring and pathetic lives; or maybe they're escaping their exciting and overly burdening lives." As it stands, this explanation is little more than a restatement of what is observed: that people often find it easy to have online sex and that it is powerful. We still do not know why projection should so easily take a sexual form, and fantasy is part of the standard explanation for why online sexual relationships, which may sustain people for years, often fail on meeting off-line (Adamse & Motta, 1996; Hamman, n.d.).

A medical-like model phrases Internet usage in terms of addiction, with Netsex seen as either reinforcing this addiction or as a special subcategory of addiction. Cooper, Scherer et al. (1999, p. 154) state, "The first position to emerge was that Internet sexuality is pathological." One therapist quoted by Shachtman (2000) claimed that "cybersex is the crack-cocaine of sex addiction." Online therapist Kimberly Young (n.d.-a) argues that "Cybersexual addiction has become a specific sub-type of Internet addiction" and estimates that 1 in 5 Internet addicts are engaged in online sexual activity. Young (n.d.-a) goes on to remark on the rapid engagement of those with "no prior criminal or psychiatric history" in such behaviour (see also Delmonico, 1997). This is pathologising with a vengeance and guides attention away from events into morals.

Cooper, Putnam, Planchon, and Boise (1999, p. 77) distinguish three types of users of Netsex. First, there are the "recreational or nonpathological users." Second, there are "[i]ndividuals who exhibit sexually compulsive traits and experience a fair amount of trouble in their lives." Third, there are users without histories of sexual compulsivity, but whose "online sexual pursuits have caused problems in their lives" (p. 80). The latter group is held to contain "depressives" who withdraw from off-line social interaction, and "stress reactive types" who use Internet sex to cope with stress or to escape from certain feelings. For another division, see Leiblum (1997). Ferree (2003) claims that women are overrepresented among Internet sex addicts, basing her claims almost entirely on Cooper, Scherer, et al.'s (1999) MSN survey. While it would be foolish to deny people can become addicted to Netsex, it does not seem realistic to make addiction the prime explanation.

In contrast, other views suggest that Netsex is therapeutic or liberatory. Hamman (1996) writes that his informant Rebecca feels that "cybersex has allowed her to become more comfortable with her body as well as her own sexuality." Cooper and Sportolari (1997) write, "When usually hidden parts of the self are seen and accepted by other(s) the experience can be healing, allowing for the gradual integration of that split-off part of the self into the overall personality" (see also Adamse & Motta, 1996). Likewise, online intimacy supposedly frees people from the tyranny of physical appearance. Wallace (1999) describes some research on the importance of physical attractiveness in relationships off-line and its lack of effect online. However, if people are freed from the necessity of looking attractive, attraction can still be increased by fluent writing styles, and can become important again when people meet.

These therapeutic arguments suggest that the external society is repressive of either sex or vital aspects of the personality, and that online life is a compensation or relief valve for this suppression (Hamman, 1996). This liberation may be seen as gendered: According to an MSNBC (1998) article, the psychologist Marlene Maheu said,

Women online are not constrained by the traditional mores we have to struggle with. Since half the sexual population is females, it would make sense that given a chance to speak up, this repressed minority would have something to say.

In other ways, this liberation may also make people nervous as it also liberates those whose sexual behaviour may not be approved and allows them to team up with others of the same ilk. Wallace (1999), writing about online groups and who apparently focused on more extreme sexual behaviours, states that there has been little research to "determine who actually participates, what their motives are and how the availability of these anonymous and introduced outlets for consensual deviance affects them" (p. 155).

Some writers claim that Netsex is safe sex, without the risks of disease, violence, or pregnancy (Hamman, 1997; Sagan, 1995; Sannicolas, 1997), and that this allows people to express themselves with greater freedom (Benedikt, 1995).

Although one set of dangers may decrease, this does not prevent people fearing other dangers such as falling for a fantasy, being uncertain of a partner's gender, or being subject to electronic harassment or to discredit in their online life through having pictures or transcripts posted to family or employers. People seem to find Netsex as fraught or complicated as off-line sex. In fact, complexity and failure might increase because of the absence of immediate and verifiable feedback (Marshall, 2003).

Potential anonymity shares in this ambivalence. Sometimes, in keeping with the liberation or therapeutic argument, removing constraining social roles and appearances is thought to be beneficial, thus enhancing

other factors such as propinquity, rapport, similarity, and mutual self-disclosure, thus promoting erotic connections that stem from emotional intimacy rather than lustful attraction ... (Cooper & Sportolari, 1997)

People are also held to be free to develop without fear of social consequences (Branwyn, 1993).

On the other hand, anonymity is supposed to increase the ease of irresponsibility, of fraud and deceit, and of socially reprehensible behaviour. Schnarch (1997) argues that anonymity may prevent depth of both self-knowledge and knowledge of the other. However, people generally attempt to work at reducing the anonymity of those they interact with; the problems of identity and gender become problems to be solved, not to be suspended.

Gendered Responses to Netsex

Without ignoring harassment, there is surprisingly little discourse about gender-based differences in the use of Netsex. Young (n.d.-b) writes,

Men tend to seek out dominance and sexual fantasy on-line, while women seek out close friendships, romantic partners, and prefer anonymous communication in which to hide their appearance ... As men tended to look more for

Cybersex, women tended to look more for romance in Cyberspace ... I should note that it is not unusual for women to engage in random Cybersex, but many times they preferred to form some type of relationship prior to sexual chat.

In Cooper, Scherer et al.'s (1999) study of Netsex on MSN, it appeared that:

men most prefer[red] Web sites featuring visual erotica (50% men to 23% women) ... and women favor[ed] chat rooms (49% women to 23% men) ... It is significant that 51% of women reported they never download sexual material. Women, on-line as elsewhere, prefer more interaction and the development of relationships.

Ferree (2003) agrees with both these claims, adding that women are more likely to seek off-line contact. This is an area that needs further research.

CONCLUSION

The positions described above oscillate around issues of liberation or escape, safety or danger, conflicting realities of the off-line and online, affection vs. distance, therapy vs. dissipation, certainty vs. uncertainty, and anonymity vs. authenticity. Usually one of these factors is selected as dominant, though all of them may be involved to a degree, however conflicting. These contradictory interpretations are not just evidence of confusion, but also of the complexities experienced.

Rightly, Cooper and Sportolari (1997) emphasise the conceptually paradoxical nature of the Net: "[O]n the one hand, it seems to epitomize the alienation of the modem world, and yet it also leads to the development of supportive and sometimes intensely intimate, even deeply erotic, relationships." This paradoxical nature cannot be ignored or reduced by saying the Net is either beneficial or not (Civin, 2000). It must be explored.

Explanations should therefore include the interaction between off-line and online lives. Netsex almost certainly is influenced by the difficulties people have in forming successful sexual relationships and pairings off-line, which (whether cross-gendered or intergendered) are important for establishing their self-identities and survival in the off-line world. However, there are also specific features of online life that need to be considered. In this often-ambiguous environment with weak boundaries, with no markers of presence beyond dialogue and with little elaborated ritual code that can be imported from off-line life, some people might need to fall in love to prove an online relationship actually exists and to sustain the sense of the other's presence. In Netsex, a person can maintain the presence of the other before them via narration and by reference to a commonly available and sustainable bodily reaction. Netsex can be used to restore contact between people when the dialogue slides out of areas of mutual interest. As such, it can be like sharing a drink, or watching a film off-line.

As Western society appears to value authenticity, the conventions of authenticity, especially around intimacy, become part of the way people conduct Netsex. Thus, mistyping can be seen as evidence of genuine excitement, and as Deuel (1996) remarks, preprogrammed MOO (MUD [multiuser domain] object oriented) actions are used less the more that Netsex or the relationship becomes real. However, authenticity generates problems as the use of exaggerated gender symbols to enable the performance of Netsex may also appear to simultaneously delete the presence of real gender or a real self, which might be expressed in uncertainties and hesitations. Given that people seem to fear they could be falling for fantasy images, they hence need to bring the relationship into the off-line reality to check its truth. If the Internet has been liberating them from pressures, at this moment the constraints of off-line life appear again. This makes online relationships fraught, and the person becomes caught in a contradiction between an intimacy that is supposedly only confirmed off-line, and an equally supposed ability to only be who they really are online. Again, the contradictions are a vital part of the experience.

FUTURE TRENDS

It is likely that Netsex will continue to be an ambiguous and multifaceted feature of online life. Research needs to focus on its complexities, the ways it functions in different kinds of groups, the ways that people relate it to their daily lives, and the way it is

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used to express, subvert, and constrain gender. This may well differ with the cultural bases of the people involved.

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KEY TERMS

AOL (America Online): The largest commercial provider of Internet services. It is now part of Time-Warner.

Authenticity: The conventional assumption that there is an underlying truth to people's actions, that they should, ideally, display this truth, and that this truth is uncoverable (see Taylor, 1991; Trilling, 1974).

Avatar: A graphic representation of a person's character in a multiplayer computer game or environment. By extension, it is often used to refer to the character itself.

Chat Room: An Internet site that contains the participants in a real-time interaction. Those within the chat room can read what each other is typing. People enter the room to participate and can be banned from it. Some suppliers may allow people to temporarily, or permanently, set up their own rooms.

MOO (MUD Object Oriented): A way of communicating with others over the Internet. It could be thought of as an interconnected set of spaces set up on a single computer. Communication tends to be synchronous and unarchived, so it is not usually possible to access conversations that occurred while one was not there. A person using one of these Internet forums logs in and plays a specific named character, usually with a text description, and can write or accumulate programmed objects, rooms, or devices that add to the environment. This means that he of she has some prop support for playing the character.

MSN (Microsoft Network): A commercial supplier of Internet connection, shopping, and chat rooms.

Teledildonics: The hypothesised use of complete virtual reality to have sex at a distance. The imagined form usually involves the participants wearing bodysuits that stimulate areas of the body and convey the results of the actions of one person to the bodysuit of the other.

Online Life and Online Bodies

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INTRODUCTION

Bodies are often claimed to be irrelevant to online activity. Online space, or activity, is frequently described as if disembodied, and often this absence of visible bodies is said to contribute to freedom from social pressures around gender, race, and body type (Reid, 1996). However, without bodies, people could not access the Internet, and online there are continual references, directly and indirectly, to bodies, so the term disembodied references a particular type of "ghost" body. Therefore, rather than accepting ideas that naturalise dislocating life online from bodies, it is necessary to explore the situations in which this occurs. Another commonly used body metaphor is the cyborg: the melding of human with machine. In both cases, the body is usually taken as underlying what is happening and as a referent for authenticity.

BACKGROUND

Bodily Referents

In online discourse, signs of the body, such as emoticons (or "smileys" as they are also called), written emotions (*kiss*, *hug*, <smile>, or acronyms such as ROFL [roll on the floor laughing]), and so forth are quite common. These emoticons substitute for gestures and seem more usual in informal situations. However, out of the vast range of emoticons depicted in dictionaries of such things, only three are commonly used in the West: the facial representatives of **:)**, the smile, indicating good humour; **:(**, the frown, indicating sadness or disappointment; and **;)**, the wink or wry face, an indicator of knowingness or irony, which is sometimes taken as flirtatious. **:-)**, **:-(**, and **;-)** are equivalents. In Japanese communication, it appears that far more signs are used, as well as "innovative punctuation" (Nishimura, 2003). Stories suggest that Western emoticons were not originally understandable, or easy to use, in Japan (Pollack, 1996), and neither were Japanese emoticons in other Asian cultures (Koda, 2004). As Katsuno and Yano (2002) write, these emoticons (*kaomoji*) reassert "bodily presence on the computer screen thereby readdressing what has often been called the cybernetic condition of 'leaving the meat behind'" (p. 206).

This variation indicates a need to investigate why particular body signs are deployed in particular cultures and abandoned in others. The most obvious problems that Western smileys deal with involve aggression or the resolution of irony (Dibbell, 1994). Folklore claims that the **:-)** was directly invented by Scott Fahlman (n.d.) after a joke about a physics experiment in a lift was taken seriously. Crystal (2001) also points out that Western emoticons may be simply expressing rapport, or indicating worries about the effect the text might have.

Appropriate use of these textual gestures may not only vary from culture to culture, but from group to group, and part of fitting in and building group identity involves learning to use them appropriately. Some people, mainly Western males, seem to be quite hostile to their use altogether, seeing people who use them as being linguistically lazy.

These indications of emotional or bodily states are commonly associated with gender in that Western women are widely supposed to be more at ease with emotions and use more emoticons (Witmer & Katzman, 1998). Women may also be required or need to use them to express bodily deference or attenuation in dealing with men (Gurak, 1997). Krohn (2004) suggests that along with gender differences, there may also be generational or authoritative boundaries.

Online communication is often hard to resolve; there is no immediate feedback or body language that might frame conversation, and as a result, references to the body off-line are taken as referents for private emotional states and truth states. In support of this, it seems that messages given off-list or off-line (in private) are more likely to be considered authentic than messages received on-list or online. As Kendall (1998) writes, people "privilege offline identity information over information received online ... This allows them to continue to understand identity in the essentialised terms of a persistent and consistent self, grounded in a particular physical body" (p. 130).

As well as the more temporary emotions, moods such as anger, mourning, sex, or so on can be generated by repeated postings of the same type. These moods then act as a way of framing and resolving communication, either deliberately as in Netsex, or sometimes accidentally when a whole group may seem overwhelmed by flame.

History of Ghosts

In the West, the person and his or her typing body are often alone, cramped, and restrained, although there is nothing inevitable about this particular bodily usage of computers. As Haraway (1989) remarks, "our machines are disturbingly lively and we ourselves frighteningly inert" (p. 152). This off-line constraint can contrast strongly with personal boundaries online that can appear fluid as long as there is no pain. Bodies are sometimes described as extended through the wires, which could easily contribute to a sense of disembodiment (Marshall, 2004).

However, the use of metaphors of disembodiment may have some other function or cause, and it is possible this is interconnected with the history of ideas of the nonphysical, the spiritual, or the ghostly, which might in turn be connected with the gendered history of the Net. A common point made in feminist critiques of Western philosophy and ideologies (e.g., Goldenberg, 1990) has been the tendency of male theorists either to denigrate the body and to praise transcendence, or to derive the world from a set of disembodied categories or processes, while simultaneously constructing the female as an inferior, passive, and physical body.

Whatever the precise history of this split, the ghost becomes more ethereal as this process becomes more pronounced. During the 20th century, the boundary was loosened and the ghost became more solid (Finucane, 1982), while now it seems to be ethereal again. Minds are often described in terms of computer programs, and people use these models to suggest that immortality can be achieved by downloading one's mind and memory into a machine (Moravec, 1990). In science fiction, there are many examples of personalities or spirits being active in computers or computer networks. Such theories tend to imply bodies are discardable and not part of our being.

This emphasis on people as minds could also be linked with the constant attempts to characterise the new elite supposedly dealing with immaterial information as knowledge workers rather than physical service workers or the valueless unemployed (who tend to be ghosted from political action). In some ways the idea of the information economy also ghosts, or displaces, the material basis of power.

If such seems plausible, then as the Internet was built and first colonised by Western males seeking dominance or proficiency via the supposed excellence of their mental, creative, or administrative abilities, it might be expected that they used the Internet to emphasise etherealization as part of their construction of their male, or elite, identity. Hall (1996) writes,

> *Bodyless communication, then, for many men at least is characterised not by a genderless exchange but rather by an exaggeration of cultural conceptions of masculinity—one realised through the textual construction of conversational dominance, sexual harassment, heterosexism, and physical hierarchies.* (p. 158)

It could be expected that some women would be apprehensive with these exclusionary constructions, and Taylor and Saarinen (1994) wrote that their female students using e-mail were:

> *much more uneasy about the "out-of-body" experience they are having than the men. Cynthia and Kaisu are obsessed with email and yet are deeply disturbed by the evaporation of the material and the absence of face-to-face. The men in the class are much less bothered by all of this.*

People could also fight against the disembodying through the use of emoticons or the expressiveness of their bodies.

Contradictions arise as the off-line body can be seen as feminine if compared to the online spirit (true expression of authentic being), but as masculine if seen as active rather than ineffective (with computer use as an escape from, or abandonment of, real life). The representations of bodies can depend on the context of invocation.

Deletion can also occur by reference to gender, particularly when it is conceived as a polarity as it then tends to delete aspects of a person's self that they actually share with the contrasting gender. The resultant tendency magnifies the possibility of distancing the body, which can only be grounded by reference to an excess of symbolic gender (making an ideal body), effectively distancing the body even further. There is no pause in which to explore the underlying feelings or the kinesthetic that might be held to render us present. The cyberbody (particularly on a MOO [MUD (multiuser domain) object oriented] or IRC [Internet relay chat]) becomes constructed as a dyad: ghost and irrelevant matter. Sexuality bridges the gap between these separated poles and charges them with their apparent energy. As Reid (1996) writes, "Cyborgs are born of virtual sex. At the moment of orgasm the line between player and character is the most clouded and the most transparent" (p. 341).

Cyborgs

The cyborg, a melding of human and machine, is also a common, although more deliberate, metaphor. As is well known, Donna Haraway (1989) proposed that the cyborg was a way of dealing with the "border" wars between animal and human, human and machine, and the physical and nonphysical, and was postgendered without being seduced by a desire for wholeness. As gender is vital to Western self-regulation and online behaviour, and people often seem regulated by their machines, there is cause to be sceptical of these assertions.

Cyborgs also have histories and origins despite Haraway's (1989) assertion that "the cyborg has no origin story in the Western sense" (p. 150), her dismissal of this descent as "illegitimate" (p. 151), or her arbitrary separating of it from the android or robot (Haraway & Goodeve, 2000). In many novels and films, the line is vague, and Sawdy (2002) argues that early modern mechanical men grew out of a vision of human nature as purified from irrational (feminine?) emotions. The Renaissance cyborg was "a refuge, a place of sanctuary, a hardened carapace into which the battered psyche might flee ... Only to be an engine is to be free" (p. 174). We might also think of the Luddites as protesters against being made slaves to the machines that overrode their own rhythms of work. Nowadays, if we are employed, we are conceivably in constant computerised touch with work; there are no boundaries to employment. As Wood (2002) points out, an automaton can be either a machine simulating the human, or a human who acts like a machine.

Many theorists involve gender explicitly in "cyborgization." Becoming cyborg can not only be seen as a way of avoiding gender, but of reinforcing it or making symbolic armour for a threatened male ego. Cyborgization, when it is not seen as radical, is usually seen as avoidance of the tender or fleshly feminine and hence as an exaggeration of ideas of masculinity and its transcendence of the (gendered) flesh. Bukatman (1993) summarises the ideas of Springer, Foster, and Dery, suggesting that under a system of technological control, where boundaries and command are drawn and imposed from above, men can identify with the machine and release their fear of dissolution in aggression against outsiders. When women are heroes in cyborg movies, they are also hard (Bukatman). Silvio (1999) demonstrates that an apparently radical cyborg anime actually portrays the control of a female body by a male spirit. For various other views and histories of cyborgs, see Gray (1995).

This leads to the question of whether more aggressive Net users see themselves as cyborgs with greater ease than less aggressive, or whether cyborgization primarily functions in Net discourse to indicate one is an insider and deeply implicated in knowing cyberspace.

Cyborg theory, when used to elucidate online life, tends to be so lax in its definition of cyborgization that there is little difference between being a cyborg and tool use. Although this may be useful in deconstructing ideas of the artificial as opposing the natural, it does not seem to help in analysing actual online experience.

For example, one version of this theory implies that computers are tools that enable self-expression that would otherwise be socially impossible:

Without computer mediated communication, Rebecca would be cut off from a part of herself. Without computers, she could not reach her potential as a human. She could not be fully human ... Rebecca is part human, part machine, and without the machine, she would remain only partly human. The boundary between the human and the machine has blurred. Rebecca has become a cyborg. (Hamman, 1996)

It is doubtful that this tells us much more than Rebecca can use a tool to express herself. We could add that this tool probably has effects on this expression—it both enables and restricts—without using the term cyborg. Similarly, the term can be used to refer to human incompleteness, as can be done without its use. Ito (1995) writes, "[T]o borrow Donna Haraway's imagery, I would like to look at mudders as cyborgs that are never whole." Sometimes it can inadvertently lead to separations, as in the following:

Here it is being suggested that email cyborg intimacy is quite different from bodily-based intimacy; that, in fact, the email cyborg self is a very different self from the body-based self. The implication is not that one shouldn't have email affairs, but that email affairs are distinct things from bodily affairs, and that the two should not be confused. (Stratton, 1997)

The cyborg, in this formulation, almost pathologises the very ambiguity that makes the e-mail affair powerful and possible. Likewise, Reid's (1996) assertion that MOO characters, as cyborgs, "redefine gender, identity and the body" (p. 329) claims too much. People can play with identifiers, but ultimately want to know the "reality" when it shifts out of play mode, and their awareness of online and off-line differences and off-line cultural meanings drives their social dynamics.

Research into the actual use of cyborgs as images shows that portrayals of cyborgs on the Internet tend to be thoroughly gendered (DeVoss, 2000), and Wilkerson (1997) writes that "from the standpoint of feminist bisexual identity ... I contend that this [cyborg] myth evades the very issues of race and sexuality which it seems to be addressing" (p. 164) and suggests that "it is vitally important to keep tensions of race and sexuality present rather than to blur the boundaries" (p. 172).

Cyborgization seems to contrast with the discourse of disembodiment, but may be implicated in it. Cybermachines, according to Haraway (1989), are not haunted, yet they appear more lively than us and hence haunted. When she claims that:

[o]ur best machines are made of sunshine; they are all light and clean because they are nothing but signals, electromagnetic waves, a section of a spectrum, and these machines are eminently portable, mobile ... Cyborgs are ether, quintessence. (p. 153)

it suggests that cybermachines are already homes for disembodiment as is implied by the immortalism of Moravec (1990). The connection of the disembodied intellect with etherealization is further suggested by Haraway's admission that her cyborg has no disruptive unconsciousness. She explains this by her reluctance to embrace the totalising explanations of Freudian psychoanalysis as if that included the only theory of the unconscious (Haraway, 1991). In a way, the ghost and the cyborg are related for they both have the tendency to delegate our bodies to the scrap heap and make them secondary to machine transcendence. This may not be supposed to happen, but the question is whether it does or not, not whether it should or should not.

The cyborg and the ghost further intersect in the virtual body of the records kept about a person, which may be treated as more important than the off-line body by corporate or government agencies without the person themselves being aware of it. Cyborg power may always be displaced elsewhere.

CONCLUSION

People continually refer to their bodies and to processes associated with the body in order to frame and resolve communication and to decide appropriate behaviour and responses. Metaphors of ghosts and cyborgs play their own roles in this process, but they are not neutral and feed into previous off-line histories of gender and technology. Rather than on abstract conception, research about life online needs to focus on the culturally specific ways that references to the body are used, and the off-line history of these references.

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KEY TERMS

Android: An artificial humanoid. They may be robotic, biological, or both. In folklore, the distinction between humans and androids seems to be that humans have emotions, or some kind of irrational mentation, which makes them superior and able to overcome the androids.

Cyborg: A cybernetic organism, or usually a melding of human and machine. The idea originally seems to have been to replace parts of humans by machines so that they could survive in space or other harsh environments. The ambiguities of the cyborg became clear in the British children's science-fiction program *Dr. Who*, in which the cybermen who replaced their human parts with machines became strictly hierarchical galactic warriors in the process, and only ambiguously human.

Emoticon: An icon depicting emotions. The term is usually used to refer to what are called "smileys," which are glyphs that are, in the West, read sideways. Japanese smileys are read vertically rather than horizontally. Often the term is extended to cover other textual expressions of emotion or bodily expression such as <OWWWW!!!>.

Framing: The theory that meaning is decided by the context or frame. Thus, the same set of words can have different meanings depending on the frame brought to them. Framing can be contested, and much politics is about framing things in such a way that one's own political discourse makes sense and the other's does not (see Bateson, 1972; Goffman, 1974; Tannen, 1993).

Luddite: The Luddites were workers in the 19th-century British cloth industry who objected to the new looms because the looms destroyed their self-determined patterns of work, left the tools in the hands of managers, and de-skilled their craft-based activities, leaving them to work harder for less income. They smashed some looms and in turn were smashed by the state (see Sale, 1995).

Outsourcing to the Post-Soviet Region and Gender

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INTRODUCTION

The purpose of this article is to analyze the outsourcing of information technology (IT) jobs to a specific world region as a gendered phenomenon. Appadurai (2001) states that the contemporary globalized world is characterized by objects in motion, and these include ideas, people, goods, images, messages, technologies and techniques, and jobs. These flows are a part of "relations of disjuncture" (Appadurai, 2001, p. 5) created by an uneven economic process in different places of the globe and involving fundamental problems of livelihood, equality or justice. Outsourcing of jobs (to faraway countries) is one of such "disjunctive" relationships. Pay difference between the United States (U.S.) and some world regions created a whole new interest in the world beyond American borders. Looking for strategies to lower costs, employers move further geographically; and with digital projects, due to their special characteristics, distribution across different geographical areas can be extremely effective. First, digital networks allow reliable and real-time transfer of digital files (both work in progress and final products), making it possible to work in geographically separated locations. Second, in the presence of adequate mechanisms for coordination through information exchange, different stages of software production (conceptualization, high-level design and low-level analysis, coding) are also separable across space (Kagami, 2002).

In the Western hemisphere, the argument for outsourcing is straightforward and powerful. It is believed that if an Indian, Chinese, Russian or Ukrainian software programmer is paid one-tenth of an American salary, a company that develops software elsewhere will save money. And provided that competitors do the same, the price of the software will fall, productivity will rise, the technology will spread, and new jobs will be created to adapt and improve it. But the argument against outsourcing centers on the loss of jobs by American workers. Although there is no statistics on the number of jobs lost to offshore outsourcing, the media write about the outcry of professionals who several years ago considered themselves invulnerable.

BACKGROUND

With digital networks, global enterprises gained access to a skilled labor force like never before. Roughly at the same time, former Soviet high-tech professionals became available for the global employment market after the disintegration of the USSR in 1991 and the decay of its science-military-industrial complex, previously their main employer. Though the bigger nations of India and China continue to be main outsourcing destinations, Eastern Europe has been noted as a promising region. Science and technological development used to be a part of the Soviet pride, and *Whitepaper on Offshore Software Development in Russia* (2001) admits that:

> *Russia's major advantage over other common offshore software development locales is the technical skills and education of its workforce. Russia has more personnel working in R&D than any other country, and ranks 3rd in the world for per capita number of scientists and engineers. Many of these engineers have solid experience and accomplishments in advanced nuclear, space, military, energy and communications projects.* (p. 4)

The same is true for Ukraine, Belarus and, to some extent, Kazakhstan, which used to be highly technological areas during the Soviet period.

CURRENT TRENDS

The mechanism of the region's interaction with international IT jobs providers was (and still is, in part) shaped by the specific trends peculiar to the period after 1991, termed as "transition." The reconfiguration of the fundamentally important social institutions and economic restructuring, to an extent, took the form of "privatization of the state" by those best positioned in the old society and now becoming capital owners. At the same time, national output declined drastically (and still has not reached the level of prior to 1991 in any post-Soviet countries), and the new businesses were emerging in the climate of downward movement and the absence of strong governing and market institutions. Initially, much of the subcontracting into the region arose within informal economy. First, IT groups that developed projects for Western customers were growing on the basis of friendly networks in research laboratories or departments whose members would establish contacts with a western IT contractor, often through a colleague who had relocated, and were paid in cash for short-term projects. With time, transnational employers working with semi-formal or informal groups were complemented with foreign-owned/offshore ventures, establishing permanent offices in the country, but hiding their real outputs from state fiscal agencies. Much of the outsourcing into the region is involved with shadow economy, and "many programmers are paid in cash," the *Whitepaper* (2001, p.12) recognized. According to my data, based on interviews conducted in Minsk in 2005, employees may get about 30% of their salary "officially," while 70% is provided "in an envelope," which implies tax evasion. Cash flows to thousands of people employed in offshore software services via global banking systems, as IT (electronic communications and computer technologies in general) is at the core of these systems. Some virtual employers, which may be "non-existent" in the legal space of post-socialist countries, might be interested in this arrangement as well, when the very "concept of a 'job'—a working place with a contract, employees' rights, sick leave, retirements, working hours—is being abolished" (Rotkirch, 2001). What matters is the final product: its cost, quality and availability to a deadline.

In the 1990s, post-Soviet societies seemed to have lacked the political will to make use of the opportunities for national economies, arising from a strong base in science and technology, while universities continued to provide, as a legacy of socialism, nominally free education for IT (and most other) specialists (alongside with new "commercial" educational opportunities). Currently, 200,000 engineers (of all types and specializations) are prepared annually in Russia alone. Many of these find jobs with transnational IT employers, while benefiting from national social resources: free education, almost free healthcare, extensive systems of affordable public transportation or housing, to name a few. Largely functioning within shadow economy, employing specialists on a temporary basis, withholding from involving with institutions and paying their virtual employees non-taxable cash, some of the outsourcing is similar to the "hijacking" of public resources and has smaller beneficial effects on host societies than they potentially might be. The trade-off, involving a restricted social group and in the absence of methods of administration of the technological-social system as a whole, does not yield adequate investments into national social needs nor spreads extensively across industries: It rather implies buying, at discount prices, its intellectual resources.

The local computer lobby, though, normally resorts to the rhetoric of the good of the nation or even national salvation when justifying the place of honor for IT. The logic of IT as national salvation in the long run is about economic interests of a certain group of people and of particular companies, and thus, is a part of the discourse over wage/economic inequality that emerged in post-socialism. Economists tend to explain higher wages of IT professionals in most national economies by the growing demand in skilled labor (James, 1999). This is only partially the case with post-Soviet high techs, whose salaries tend to be higher because they participate in the global, not national, employment market. The role that IT may play in national economies depends on the social context. It may tend to accentuate, rather than ameliorate, economic and technological differences. Gains from IT accrue mainly to economic agents that form part of the modern technological system in respective countries, as distinct from agents who belong to the traditional system

(James, 1999); small business, unable to introduce high-end products; or state-funded sectors (teachers and doctors). These latter groups may be worse off than before new IT products were introduced, which they are unable to buy (James, 1999).

IT elites (predominantly male), arguing their corporate interests of "world-scale" pay, are among the youngest, most energetic and well-off Russians, as well as Ukrainian or Belarusian urbanites, who, according to the sociological polls, are also the group most favorably looking at tax evasion (Klyamkin, 2000), because they are well positioned to take advantage of it. Young professionals possess expert capital, rooted in certain competencies that, in the era of global labor force, has greater value than before and becomes a basis for moral capital. Their class situation might be viewed as that of a distinct group based on their common unique relationship to the new technological base of modern capitalism. The claim of national salvation through new technologies veils the fact that in the neo-liberal economic restructuring, those benefiting from it are largely those involved with it.

In the post-Soviet job market, corporations granted some high-tech specialists an increase in wages; in return, they demanded a different type of work contract. The new arrangement is based on the idea of an autonomous and competitive, risk-taking "global" worker whose private matters are not supposed to interfere with the pursuit of profit in a market-driven system, while someone else just takes care of them. As corporations were moving overseas in search of skilled labor, outsourcing became embedded in the general process of reconfiguration of gender relations in the post-Soviet region. Under socialism, power relationships were structured differently, as Soviet women were more dependent on the socialist state than on men for their livelihood. Historically, USSR had the highest rates of female labor participation in the world: Nine out of 10 women of reproductive age worked. They entered the workforce massively in the early 1930s, when the socialist industrialization project was launched, and by the 1980s were better educated than men (in terms of their ratio among those with college degrees). Their numbers in science and technology were equally significant and, probably, higher than in any other country: According to some estimates, they made 40%.

As women were very intensively involved in the workforce, the birthrates were falling, and eventually a system of extended benefits was worked out to support motherhood through social policy. It embraced paid parent leaves (e.g., partially paid leave of 3 years to take care of a new child, or fully paid leaves to take care of a sick child, available for any family member, but usually taken by mothers, were counted as work time for retirement), free childcare and healthcare, and so forth. The Soviet gender arrangement was mostly a dual earner/state career contract (Rotkirch, 2001) that did not radically reverse the traditional belief that family obligations are more women's work than men's. The benefits were especially good with richer employers, like the military/science/industrial complex, which provided its workers with holiday packages, sanatoria, children's camps, daycare centers, sports facilities and so forth. Thousands of women were employed there as researchers and engineers and especially programmers, while men were more involved with hardware development (believed to be a male thing). Programming was viewed as less prestigious.

Post-Soviet radical economic and social reforms, carried with the advice of such proponents of neo-liberal economics as the World Bank and International Monetary Fund, included partial dismantling of the system of social services. Sperling (1999) states that when receiving Western loan money, enterprises were required to turn their social services elsewhere, as these were impending economic efficiency. The employees most dependent on leaves and benefits because of family responsibilities turned out as inconvenient in the new system and were massively rejected (under various pretexts) by the market-oriented companies. In the post-communist neo-liberal discourse, social issues began to be largely seen as individual, not collective, responsibility and largely associated with women. As the social policy changed, caring work, without which no economic or social system can function (Jochimsen, 2003), was relegated from the state to the private sphere. In households with perceived lack of time, care may be provided by hired domestic workers, but most often it comes from wives (Rotkirch, 2001).

Meanwhile, as hardware development, which requires investments into facilities and equipment, was largely gone from the job market, and programming became relatively well paid, it turned into a prestigious and mostly male occupation. Ahuja (2002) states that recent trends towards globalization hamper women's chances of hiring or retention IT positions, due to structural and cultural factors. Women were drifting out if IT, as high-tech jobs in the state sector disappeared, and corporations, not concerned with any social provisions, became main employers. New software groups and joint ventures, started through the old boys' net, were either reluctant to hire women or organized in a way that did not imply the private sphere and demanded what was perceived as "male qualities" but, in fact, implied a certain lifestyle, characterized by long working hours and excluding participation in caring work, which is viewed as distracting employees from exclusive concentration on their task. Work-family conflict, social expectations and occupational culture together produce barriers in women's professional lives.

CONCLUSION

Outsourcing to the post-Soviet region became possible after the disintegration of the USSR in 1991 and the decay of its science/military/industrial complex. It became involved with the economic restructuring (transition from central administrative economy to the market economy) and post-socialist emergence of a new systemic superiority of men over women, as the system of social security was reshaped. In this situation, outsourcing was benefiting smaller groups of knowledge workers involved with it. Recently, post-socialist governments that became aware of the potential of outsourcing began developing some policy decisions to use it in the interests of local societies.

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KEY TERMS

Military-Science-Industrial Complex: The aggregate of a nation's armed forces (military establishment), the industries that supply their equipment, materials and armaments, and research units that conduct military-funded research and development.

Neo-Liberal: Neo-liberalism is a political-economic philosophy that de-emphasizes or rejects government intervention in the economy, focusing instead on achieving progress and even social justice by encouraging free-market methods and fewer restrictions on business operations and economic development. The main points of neo-liberalism include the rule of the market; cutting public expenditures for social services; reducing government regulation; privatization; and replacing the concept of "public good" with "individual responsibility."

Outsourcing: Work done for a company by people other than the company's full-time employees. Offshore outsourcing in IT involves the "relocation" of jobs oversees to areas with noticeable pay difference.

Transition: The period of political and economic change in the former communist (socialist) states after the fall in 1989 (1991 in the former USSR) of communist-led governments. The changes involve the transition from the administrative (centrally planned) economy to the market economy, and from the one-party system to liberal democracy. Sometimes termed "the transition to capitalism."

P

Pair Programming and Gender

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INTRODUCTION

Studies of pair programming both in industry and academic settings have found improvements in program quality, test scores, confidence, enjoyment, and retention in computer-related majors. In this article we define pair programming, summarize the results of pair programming research, and show why we believe pair programming will help women and men succeed in IT majors.

BACKGROUND

Traditional undergraduate introductory programming courses generally require that students work individually on their programming assignments. In these courses, working with another student on programming homework constitutes cheating and is not tolerated. The only resources available to help students with problems are the course instructor, the textbook, and the teaching assistant. They are not allowed to work with their peers, who are struggling with the same material. This pedagogical approach teaches introductory programming students that software development is an individual activity, potentially giving students the mistaken impression that software engineering is an isolating and lonely career. Gender studies suggest that such a view will disproportionately discourage women from pursuing IT careers (Margolis & Fisher, 2002).

Cooperative or collaborative learning models involve two or more individuals taking turns helping one another learn information (Horn, Collier, Oxford, Bond, & Dansereu, 1998). Some researchers differentiate between cooperative and collaborative methods by stating that cooperative learning involves students taking responsibility for subtasks, whereas collaborative learning requires that the group works together on all aspects of the task (Underwood & Underwood, 1999). The consensus from numerous field and laboratory investigations is that academic achievement such as performance on a test is enhanced when an individual learns information with others as opposed to individually (O'Donnell & Dansereu, 1992; Slavin, 1996; Totten, Sills, Digby, & Russ, 1991).

Cooperative activities have been taught and practiced for other software system development tasks such as design and software engineering but not for programming (Basili, Green, Laitenburger, Lanubile, Shull, Sorumgard, et al., 1996; Fagan, 1986, Sauer, Jeffrey, Land, & Yetton, 2000; Schlimmer, Fletcher, & Hermens, 1994). Often cooperative methods are used in upper division computer science (CS) courses such as compiler design and software engineering in which group projects are encouraged or required. In these courses, the group projects are split up by the group members and tackled individually before being recombined to form a single solution. Sometimes a software engineering instructor offers assistance to the student groups regarding techniques for cooperation but these topics are rarely discussed in other CS courses.

The benefits of collaboration while programming in both industrial and academic settings have been discussed by Flor and Hutchins (1991), Constantine (1995), Coplien (1995), and Anderson, Beattie, Beck, Bryant, DeArment, Fowler, et al. (1998). However, the recent growth of extreme programming (XP) (Beck, 2000) has brought considerable attention to the form of collaborative programming known as pair programming (Williams & Kessler, 2003). Extreme programming is a software development method that differs in a number of ways from generally accepted prior software development methods. These differences include writing module tests before writing the modules, working closely with the customer to develop the specification as the program is developed, and an emphasis on teamwork as exemplified by pair programming, to name just a few. The emphasis on teamwork is an aspect of extreme programming that may be particularly appealing to women.

With pair programming, two software developers work side-by-side at one computer, each taking full responsibility for the design, coding, and testing of the program under development. One person is called the driver and controls the mouse and keyboard; the other is called the navigator and provides a constant review of the code as it is produced. The roles are reversed periodically so that each member of the pair has experience as the driver and navigator. Studies have shown that pair programming produces code that has fewer defects and takes approximately the same total time as when code is produced by a solitary programmer (Nosek, 1998; Williams, Kessler, Cunningham, & Jeffries, 2000). Any code that is produced by only one member of a pair is either discarded or reviewed by the pair together prior to inclusion into the program.

PAIR PROGRAMMING IN THE CLASSROOM

Early experimental research with pair programming using small numbers of students or professional programmers found that pairs outperformed those who worked alone (Nosek, 1998; Williams, Kessler, Cunningham, & Jeffries, 2000). Pairs significantly outperformed individual programmers in terms of program functionality and readability, reported greater satisfaction with the problem-solving process, and had greater confidence in their solutions. Pairs took slightly longer to complete their programs, but these programs contained fewer defects.

A series of experiments conducted at the University of California at Santa Cruz (UCSC) (Hanks, McDowell, Draper, & Krnjajic, 2004; McDowell, Werner, Bullock, & Fernald, 2003a; Werner, Hanks, & McDowell, 2005) found that students who pair programmed in their introductory programming course were more confident in their work. They were also more likely to complete and pass the course, to take additional computer science courses, to declare computer-related majors, and to produce higher quality programs than students who programmed alone.

Naggapan, Williams, Ferzli, Yang, Wiebe, Miller, et al. (2003) report that pair programming results in programming laboratories that are more conducive to advanced, active learning. Students in these labs ask more substantive questions, are more productive, and are less frustrated.

To ensure that paired students enjoy these benefits, it is important that they have compatible partners. Researchers at the University of Wales (Thomas, Ratcliffe, & Robertson, 2003) investigated issues regarding partner compatibility for pair programming students. They asked more than 60 students to indicate their self-perceived level of expertise and confidence in their programming abilities, and used these rankings to evaluate pairing success. It is important to note that self-reported ability and actual ability are different measures, as 5 of the 17 students who felt that they were highly capable did very poorly in the course.

Thomas et al. found some evidence that students do their best work when paired with students with similar confidence levels. Students with less self-confidence seem to enjoy pair programming more than those students who reported the highest levels of confidence. As there were only seven women in the class, no conclusions about how pairing affected them can be made.

Researchers at North Carolina State University investigated factors that could affect student pair compatibility. Out of 550 graduate and undergraduate students, more than 90% reported being compatible with their partner (Katira, Williams, Wiebe, Miller, Balik, & Gehringer, 2004). Factors such as personality type, actual skill level, and self-esteem appear to have little, if any, effect on partner compatibility. The authors do not discuss any relation between gender and compatibility. Students reported they were more compatible with partners who they perceived to have similar levels of technical competence as themselves; unfortunately, there is no proactive way that instructors can use this factor to assign partners.

The benefits of pair programming are enjoyed by all students, but women students appear to benefit more. Research conducted at UCSC (McDowell, Werner, Bullock, & Fernald, 2003, Werner, Hanks, & McDowell, 2005a) indicates that although students who pair are more confident in their work and are more likely to declare computer-related majors, these increases are greater for women than men.

The UCSC study looked at four sections of an introductory programming course over three academic terms, one in the fall, two in the winter, and one in the spring. The fall and winter sections required pair programming; the spring term required students to work alone. The fall and spring sections were taught by the same instructor; the winter sections were taught by two additional instructors. Students enrolled into sections without knowing about the pair programming experiments. There were no differences in SAT Math scores or high school GPA between the pairing and non-pairing groups.

Among the UCSC introductory programming students who indicated intent to declare a computer-related major, 59.5% of the paired women had declared a CS-related major one year later, compared with only 22.2% of the women who worked alone. Men who paired were also more likely to declare a CS-related major within one year of taking the introductory course; 74.0% of the paired men had declared a CS-related major compared with 47.2% of the men who worked alone. This is an instance of a possible positive impact on the gender gap due to pair programming. Without pairing, men are 2.13 times more likely than women to declare a CS-related major. When pairing is used, men are only 1.24 times more likely than women to declare a CS-related major.

In this same study, the confidence of students was also measured. To assess student confidence levels, students in the study responded to the question, "On a scale from 0 (not at all confident) to 100 (very confident), how confident are you in your solution to this assignment?" when they turned in each of their programming assignments.

Overall, students who were paired reported significantly higher confidence in their program solutions (89.4) than students who worked independently (71.2). Although men as a group were significantly more confident (87.0) than women (81.1), there was a significant interaction between pairing and gender with regard to reported confidence. Simple effects follow-up tests of the interaction indicated that pairing resulted in increased confidence for both women (86.8 vs. 63.0) and men (90.3 vs. 74.6). Women's confidence increased by 24 points when they paired compared with a 15-point increase for men. Pairing had a statistically significantly greater effect on confidence levels for women and, therefore, may have a visible positive impact on the gender gap. Unpaired men reported 1.18 times greater confidence than unpaired women, while paired men reported 1.04 times greater confidence than paired women. Pairing seems to close the confidence gap between women and men.

FUTURE TRENDS

The Pipelines column of Computing Research News published a short article on pair programming (Werner, Hanks, McDowell, Bullock, & Fernald, 2005b). Computing Research News is a publication of the Computing Research Association whose mission is to influence policy. The appearance of this topic in a publication directed at computing related department chairs of PhD granting institutions is indicative of its importance to the future of introductory computer programming instruction.

One drawback of pair programming is its collocation requirement. We are investigating techniques for extending pair programming to situations where it is difficult or impossible for students to physically meet (Hanks, 2004, Hanks, 2005).

Recommendations for next steps with this research include: the study of pair programming in high school and middle school, additional study about pair compatibility and what is needed in order to increase performance, and to determine what strategies or instructional support is needed to create effective pairs.

CONCLUSION

Why does pair programming hold promise for closing the gender gap regarding the field of information technology? The American Association of University Women Education Foundation Commission on Technology, Gender, and Teacher Education's report in 2000 gives four reasons for the decline in enrollment of women in computer science (CS) programs. These reasons are:

1. A perception that a career in computing is not conducive to family life
2. A belief that work in the information technology field is conducted in a competitive rather than a collaborative environment
3. A perception of CS as a solitary occupation
4. Concern about safety and security about women working alone at night and on weekends in computer laboratories

The use of pair programming combats at least three of these four reasons. A typical beginning programming course requires individual work; with the use of pair programming, women may view programming as a collaborative exercise. Williams and Kessler suggest that "peer pressure" may be at work as a possible explanation for higher completion rates among paired vs. solo programming students (Williams & Kessler, 2000). It may be the collaborative aspect of pair programming that is a major reason that the students remain in the class. The increased levels of confidence that can be attributed to pairing are probably also a factor in improved retention. This same collaboration could help combat the perception of CS as a solitary occupation. Additionally, an outcome of pair programming is that no one works alone late at night or on weekends in a computer laboratory. Partners work together. We hypothesize that these reasons cause pair programming to contribute to persistence of women in CS.

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KEY TERMS

Active Learning: Based on a theory of learning where people are able to set goals, plan, and revise. This is to be contrasted with the theory of learning based on Piaget where newborns are born with a blank slate on which learning is placed.

Collaborative Learning: A learning model where students work together in a group and the group works together on all aspects of the task.

Cooperative Learning: A learning model where students work together in a group but individual students take responsibility for various subtasks.

Extreme Programming: A method of software development that emphasizes customer involvement and teamwork. One component of the teamwork is the use of pair programming for all code development.

Module: An independent part of a computer program. Different computer languages typically have their own terminology for module. Some of these are: function, procedure, subroutine, and method.

Pair Programming: A method of software development where two software developers work side-by-side at one computer, each taking full responsibility for the design, coding, and testing of the program under development. One person is called the driver and controls the mouse and keyboard; the other is called the navigator and provides a constant review of the code as it is produced.

Software Development: The development of software goes through the steps of requirements specification, design, code, test, and maintenance. The development method that is used determines the order, length, and specific details for each of these steps.

P

Parental Support for Female IT Career Interest and Choice

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INTRODUCTION

Although adolescents become progressively independent from their parents in the high-school years, they continue to depend heavily on parents in the area of career development (Peterson, Stivers, & Peters, 1986; Sebald, 1989). The role of parental support in children's career choice has been demonstrated empirically in the career-development literature (Altman, 1997; Fisher & Griggs, 1994; Ketterson & Blustein, 1997; Kracke, 1997; Way & Rossman, 1996). Researchers have found that parents impact career choice more than counselors, teachers, friends, other relatives, or people working in the field of interest (Kotrlik & Harrison, 1989), but are not adequately informed about how to help (Young, Friesen, & Borycki, 1994). Although parents hold a powerful role in the career advising of both their male and female children, most of the reported studies use a male model and focus. Researchers are beginning to develop a knowledge base for the career development of girls and the unique issues they face in deciding on a career. Greater understanding of these issues is urgent, especially as females are recruited into nontraditional fields like information technology. This article will review research on parental support for female career choice, including the research findings from the Women and Information Technology (WIT, 2002-2005) project funded by the National Science Foundation.

BACKGROUND

Early Research Findings of Parental Support for Females

Schulenberg, Vondracek, and Crouter (1984) provided the only existing review of the early published literature as they examined how families influence the vocational development of both females and males using family variables (e.g., demographic variables of the family, family configurations, and process-oriented features of the family) that have been shown to influence different aspects of vocational development. This review, covering studies conducted before the 1980s, found that the early parental-support research for both females and males demonstrated links between career development and socioeconomic status, parents' educational and occupational attainment, and cultural background

More specifically, this review of early findings identified a substantial number of studies conducted in the 1970s regarding possible associations between family process variables and women's career development. Much of this research focused on identifying family characteristics of women who had entered nontraditional careers and suggested that women who pursed nontraditional paths tended to perceive themselves as being similar to their fathers (Tangri, 1972), felt supported by their mothers (Standley & Soule, 1974), and came from families that valued educational and occupational pursuits (Standley & Soule; Trigg & Perlman, 1976).

When examining the early research, Schulenberg et al. (1984) found that except for the work of Roe (1956), who studied parenting styles and career orientation, family interaction-pattern influences on career development had virtually been ignored. Newer research was needed that investigated family interactions such as attachment, psychological separation, conflict, and enmeshment with more sophisticated research methodologies. Given the changes in the world of work, the increased participation of females in the workforce, and changes in the family, families likely influence the career development of females in different ways than in earlier generations.

A different body of research that considers the effects of family functioning is now emerging. Family functioning, a broader concept that encompasses parenting style, parental support and guidance, positive or negative environmental influences, and family members' interaction styles, has been found to exert a greater influence on career development than earlier research that examined family structure or parents' education and occupational status (Fisher & Griggs, 1994; Trusty, Watts, & Erdman, 1997). This newer approach to parental support for career development also includes the effects of parent-child attachment (Ketterson & Blustein, 1997), parent-child communication (Middleton & Loughead, 1993), parental support, guidance, positive and negative environmental influences, and family members' interaction styles (Altman, 1997).

New Studies of Parental Support for Females

A comprehensive review (Whiston & Keller, 2004) of research published since 1980 is related to family support influences on career development and occupational choice. It gives us a picture of family influences on children, adolescents, college students, and adults over the life course. While few studies of childhood and female careers were found, several findings related to communication and perceived family power were cited. Birk and Brimline (1984) studied children enrolled in kindergarten, third grade, and fifth grade and found that parents who talked to their children about their occupational goals had children who aspired toward more gender-traditional occupations. Lavine (1982) asked children aged 7 to 11 years what they wanted to be when they grew up; whether boys, girls, or both could have certain jobs; and which parent made the decisions in their homes. Findings revealed that girls who viewed their mother as having significant power within the family perceived more careers as being open to both men and women and aspired to less feminine-stereotyped careers compared with girls who viewed their mother as having little power.

In the Whiston and Keller 2004 review of research, a theme of mothers and daughters emerged, and studies related to adolescent females found that freshmen and sophomore girls were more likely than boys to report that their mothers provided positive feedback, supported their autonomy, and were open to discussions about their career decisions (Paa & McWhirter, 2000). Continuing the mother-daughter bond of influence, Fassinger's (1990) model of females' career development proposed that a complex set of relationships among agency, ability, and gender-role attitudes influence women's career orientation and choice. O'Brien and Fassinger (1993) found that the relationship with the mother contributed to the model, and their model reflected that a combination of an attachment to the mother and a healthy movement toward individuation contributes to adolescent girls' career orientation. Rainey and Borders (1997) concluded that the career orientation of adolescent females is influenced by a complex interplay of their abilities, agenting characteristics, gender-role attitudes, and relationships with their mothers. The mother-daughter relationship may be significant in adolescent girls developing a career orientation and may play a pertinent role in their feeling efficacious about career decision making.

At the college level, researchers have also found that parental attachment is positively associated with vocational exploration (Ketterson & Blustein, 1997). Felsman and Blustein (1999), and Ryan, Solberg, and Brown (1996), however, found that maternal attachment was more salient than paternal attachment. Finally, a qualitative study by Schultheiss, Kress, Manzi, and Glasscock (2001) examined family influences on both vocational exploration and career decision making. The majority of participants felt their mothers, fathers, and siblings had played a positive role in their career exploration by indirect means such as providing emotional esteem and informational support, and by more tangible means such as providing educational materials. Furthermore, 36% of participants indicated that their mother was the most influential person in their career exploration process, while 21% indicated this was true of their father.

Research Findings from the Women in Information Technology Project Related to Parental Support for Female IT Career Choice and Interest

The next section summarizes key findings from a research project funded by the National Science Foundation to explore women's interest in science, technology, engineering, and math (STEM) fields, particularly information technology (Women in Information Technology, 2002-2005). The larger project was composed of several substudies involving qualitative and quantitative research methods, and samples from a variety of populations. The analytical framework for the project was the developmental theory of self-authorship, defined as "the ability to collect, interpret, and analyze information and reflect on one's own beliefs in order to form judgments" (Baxter Magolda, 1998, p. 143). Self-authorship influences how individuals make meaning of the advice they receive from others, how susceptible they are to feedback, and the extent to which the reasoning they employ to make a decision reflects an internally grounded sense of self (Baxter Magolda, 1998, 1999, 2001; Baxter Magolda & King, 2004).

Mother and Daughter Career Conversations

One of the substudies of this larger project involved qualitative interviews with 11 matched pairs of mothers and high-school daughters (Meszaros, Creamer, Burger, & Matheson, 2005). This study explored answers to the questions of how career decisions are made and who influences them. The daughters were high-school sophomores, aged 16 to 18, from 10 urban and suburban high schools in Virginia. When asked whom they talked to about their future, 7 of the 11 girls identified their mother first, followed by friends, grandmothers, parents (both mother and father), and teachers. The daughters described career conversations with their mothers as being mostly nondirective, often including messages of support and encouragement for making good decisions about a career. Rather than directing their daughters to a specific career, the mothers served more as sounding boards and guides to other resources including the Internet and libraries. Most of the mothers reported that they did not want to influence the specific occupational choice of their children. Several mothers served in the role of providing an active information resource beyond just encouraging their daughters' good decisions. This exploratory study indicates that mothers actively support the career-decision processes of their daughters. If this is the case, mothers could benefit from additional resources about information technology and other nontraditional careers so that the guidance they provide to their daughters supports the consideration of a wide range of career options.

Sources of Influence for College Women's Career Interests

Another substudy involved interviews with college women (n=40) who were asked to identify people who had a significant influence on their career interests (Creamer & Laughlin, 2005). Nearly all (n=39, 98%) of the women identified one or both parents as influencers, while other family members, particularly siblings, were identified next most frequently (n=13, 33%). Participants were also asked why they considered opinions from these people important. The most common reply had to do with the participant's sense that the people giving advice (in most cases, parents) cared for them and would know what was best for them. For example, one woman stated, "Just because I trust them [parents and sister]—I know that they are looking out for my best interests; they're not going to tell me something that is going to hurt me." Another participant explained, "Because they're my parents and I think they know what's best for me sometimes." These findings suggest that many college women turn to parents for advice about career decisions, adding support to past studies showing the primary impact of parents on career choice (Kotrlik & Harrison, 1989). The trust placed on parents to know what is best may override the authority of others, like advisors and/or faculty members, who are better acquainted with a wide range of career options, especially in highly technical fields, but are less trusted because they do not know a student personally.

Predicting women's interest in IT. A theoretically driven path model was developed to predict women's interest in careers in information technology (Creamer, Burger, Meszaros, Lee, & Laughlin, 2005). The model is based on responses to the *Career Decision-Making Survey* (Women in Information Technology, 2005), administered between 2001 and 2005 in three waves to high-school and college women in rural and urban locations in the mid-Atlantic region (*n*=1,621). The findings presented here are from 373 high-school and college women who completed the questionnaire in the fall of 2004 and spring of 2005, resulting in a model that predicted 27% of the variance in the interest and choice of computer-related fields.

Parental support was one of three mediating variables (along with computer use and positive attitudes about IT workers) that had a significant direct effect on the dependent variable IT career choice and interest. Parental support is defined by the perceptions that parents support the importance of a career and encourage career exploration, as well as agreement with the belief that parents have an idea of what would be an appropriate career choice. Students who expressed an interest in an IT career believed that their parents support this choice. This is consistent with interview data (noted above) indicating that female college students trust parents to provide guidance about suitable majors and career options, and to know what is best for them. Parental support had a direct effect on how likely the respondent was to seek and listen to advice about career options, and how positively they viewed individuals working in IT fields. It also impacted how respondents made judgments about whose advice was considered credible. Participants whose mother had completed a college degree were significantly more likely than those whose mother had only completed a high-school degree to report parental support for a career, career exploration, and computer use.

FUTURE TRENDS

Although researchers have agreed that parental involvement in career decisions is very important, and there is a growing body of research evidence, more investigation of how and to what extent parents influence their female children's career decisions is needed (Kerka, 2001). The research on female choice of nontraditional careers such as IT is notably missing. More research is also needed for particular groups of women and girls. For instance, some research shows that for African-American females, early gender-role socialization is less sex typed, and African-American girls often experience more crossovers between traditionally male and female roles and duties in the household, perhaps making them more open to considering nontraditional careers (Hackett & Byars, 1996). There is also a need to examine both positive and negative effects of parental involvement on career decisions.

CONCLUSION

Parental support for female IT career choice and interest emerged as a key variable in the theoretically driven path model of our research. Few studies have been conducted using a family-relations approach. Viewing parental support through a family-relations lens provides insights into Baxter Magolda's (2004) theory of self-authorship with its emphasis on parental challenge and support. The parent-child literature using attachment theory suggests close relationships provide experiences of security promoting exploration and risk taking. Furthermore, parents who are willing to discuss issues openly and promote independent thinking in their children encourage more active career exploration (Ketterson & Blustein, 1997).

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KEY TERMS

Information Technology: This refers to a variety of jobs that involve the development, installation, and implementation of computer systems and applications. Careers in IT encompass occupations that require designing and developing software and hardware systems, providing technical support for computer and peripheral systems, and creating and managing network systems and databases (Governor's Commission on Information Technology, 1999).

IT Career Interest and Choice: This is the dependent variable in the Women in Information Technology path model presented in this article. It reflects an expressed interest in a career in IT or a choice to pursue a career in IT.

Nontraditional Career: This refers to a career in which less than 25% of the workforce is of one's gender.

Parental Support: In the Women in Information Technology path model presented in this article, this variable reflects the respondent's perceptions that her parents support the importance of a career and encourage career exploration, as well as agreement with the statement that parents have an idea about what would be an appropriate career choice.

Path Model: This is a statistical model that shows directional relationships between variables in the form of a diagram. The variables in the diagram are arranged according to theoretical assumptions regarding their causal relationships and are connected by paths or directional arrows that display regression weights.

Self-Authorship: "The ability to collect, interpret, and analyze information and reflect on one's own beliefs in order to form judgments" (Baxter Magolda, 1998, p. 143).

Traditional Career: This refers to a career in which more than 75% of the workforce is of one's gender.

Participation of Female Computer Science Students in Austria

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INTRODUCTION

The situation of women in computer science education has been a major topic of feminist researchers. It has received widespread attention in many countries all over the world. In general, it can be said that in almost all the countries of the world women are underrepresented in computer science education at university level. This phenomenon is, however, a very complex one. In many industrialized countries, there was a peak in women's participation in computer science studies in the middle of the 80s of the 20th century. After that, the number of women who studied computer science in these countries decreased again. This development has been discussed, for example, by Behnke and Oechtering (1995) for Germany, by Kirkup (1992) for Great Britain, and by the EECS Women Undergraduate Enrollment Committee (1995) for the USA. In recent years, there is some indication that the percentage of women who choose Computer science at universities is rising again, at least in Germany (Kompetenzzentrum, 2003) and in Austria (Österreichisches Statistisches Zentralamt, 1971-2001). Apart from that, some cultural differences can be observed. It has been mentioned in several publications that the percentage of Asian women studying computer science is often higher than that of women in Western industrialized countries (Greenhill, von Hellens, Nielsen, & Pringle, 1997).

In the following text, we want to discuss possible reasons for the increase in female computer science students in the last years in a few countries. We want to analyze the reasons for this increase. Detailed information about the motivation of women who study computer science at universities should be helpful in formulating strategies to overcome the under-representation of women in this area. Such strategies should take differences between countries into account. Case studies for single countries could provide relevant information in this context. The following text describes the situation in Austria.

BACKGROUND

The under-representation of women in computer science has been discussed quite extensively. Many reasons have been given why women apparently avoid computer science despite the fact that computer systems do influence all aspects of working conditions and the private life of people quite heavily. A higher percentage of women who take part in shaping computer technology would, therefore, be very desirable. Nevertheless, women do not feel motivated to participate in this process. Several publications have discussed the reasons for this in great detail (see e.g., Gürer & Camp, 2001; Margolis & Fisher, 2003; Schinzel, 1997).

Gürer and Camp (2001) developed a very comprehensive framework of reasons for the under representation of women in computer science consisting of 13 different issues, which have to be considered. Among these issues, Gürer and Camp mention that a positive attitude towards computers is necessary, that computer games developed specifically for boys exert a negative influence, and that equal access of girls and boys to computers is important. In general, the environment in the family, in school, at work, and in society plays a crucial role.

Schinzel (1997) discussed a few additional reasons why women do not go into computing anymore. She points out that (at least in Germany) there was "a shift in the definition of computer science from discrete applications of mathematics to an orientation towards applied and engineering sciences" (p. 368). She argues that this made it more difficult for women to identify with computer science. In her view, computer science strongly influenced by mathematics is more appealing to women. This argument is probably quite specific for Germany. There is empirical evidence that many female German computer scientists originally studied mathematics or feel very attracted by the mathematical side of computer science (Erb, 1996). This contradicts Margolis' and Fisher's (2003) view who assume that the similarity of computer science to mathematics makes it especially difficult for women to get interested in this subject. Schinzel also emphasizes the concept of highly diverse socially created gender-based interests of girls and boys.

Margolis and Fisher (2003) assume that an important reason for the under representation of women in computer science is the "geek mythology" prevailing among computer scientists. Computer science students are seen as persons who are obsessed with their machines and who are rarely ever communicating with normal people. This image is supposed to deter many women from computer science.

Margolis and Fisher also point out that there is a difference between female American students and students from other countries (especially from Asia) who study at U.S. universities. In their interviews, they found out that these students often had no previous computer experience but persisted because they experienced financial pressure either from companies, which granted them scholarships or from their families. In some cases, these women acquired an increased self-confidence towards computer science. This is also supported by the work of Greenhill et al. (1997). They investigated female Asian students of computer science in Australia who also seem to be very job-oriented.

Given that the under-representation of women in computer science still persists several authors tried to formulate measures to overcome this problem (see e.g., Gürer & Camp, 2001; Margolis & Fisher, 2003). In addition, it seems to be necessary to analyze in more detail which conditions promote the access of women to computer science studies and which do not. In Austria, for example, there has been an increase in the percentage of female computer science students during the last few years (since 1998).

Several reasons might explain this development. Especially in the year 2000, the shortage of IT experts was widely discussed in Austria and other European countries. It should be noticed that the increase of female computer science students coincides with this discussion. It might, therefore, be argued that these students were motivated by the demand for IT specialists on the labor market. In the literature, there is some indication that an increased demand for experts in specific areas can lead to a higher degree of women in the workforce (see e.g., Roloff, 1989). The economic crisis and the problems with the so-called new economy led to a decrease in the demand for IT experts but there is still a shortage of IT experts with specific skills. Another development which might be responsible for the increase in female students of computer science might be the fact that there is a tendency in Austria that young girls and women use computers and the Internet as often as boys/young men do. In the age group between 16 and 24 years, 90.9% of all women have used a computer and 68.5% the Internet. The corresponding figures for males are 90.6% and 68.3%. In contrast to that, there is a pronounced gender difference in all other age groups (Statistik Austria, 2003). This indicates that the problem of access for girls and young women is not extremely relevant anymore. A third explanation might be that in the year 2001 five different computer science bachelor studies were introduced at Austrian universities. The disciplines of media informatics and medical computer science were especially attractive for women. The introduction of such fields of specialization might aid female students to choose computer science as a subject. To find out whether there is some empirical evidence for these explanations we conducted a survey at an Austrian technical university concerning attitudes of computer science students towards their discipline. Selected results from this survey will be discussed in the next section.

RESULTS OF A SURVEY CONDUCTED IN 1993 AND 2004

In 2004, we conducted a survey, which was based on 41 females and 247 males, who are students of the BSc in computer science at the Vienna University of Technology. Most of them (256) enrolled in October

Table 1. Enrollments of the subjects, Survey, 2004

	Females	F %	Males	M %	Sum
Data Engineering & Statistics	1	**2**	4	**2**	5
Media Informatics	28	**65**	94	**37**	122
Medical Computer Science	5	**12**	23	**9**	28
Software & Information Engineering	5	**12**	82	**32**	87
Computer Engineering	2	**5**	43	**17**	45
B.Sc. Studies in Computer Science	41	**95**	246	**96**	287
Other Studies	2	**5**	9	**4**	11
Sum	43	**100**	255	**100**	298

2004—40 females and 216 males study in the first semester. Since a small number of participants study more than one BSc, the figures in Table 1 show 298 enrollments in total. The percentages in Table 1 describe the distribution among women and among men. Obviously, the bachelor studies in computer science at the Vienna University of Technology are still dominated by male students; only 14% of the subjects are female. However, there is a significant difference related to the type of bachelor study. Whereas male students tend to choose computer engineering and software and information engineering, female students prefer media informatics. Although data engineering and statistics show a participation of 20% female students, we do not consider this as relevant information because the data sample of five subjects is too small. This gender gap might indicate that the type and labeling of the Bachelor Studies activates a gender-stereotyped context. A focus on engineering seems to attract men and discourage women.

Feminist research offers three major approaches to explain this tendency (Collmer, 1997). The first model assumes a radial difference between women and men and their adoption and relation to nature and technology (Mies, 1980; Jansen, 1986). Another explanation claims shortcomings in the socialization and education of girls and women, which cause a distance to technology (Metz-Göckel, 1990; Schorb, 1990). The third approach asserts an ambivalent role of female engineers (Wagner, 1991). Women experience a double bind situation and alienation caused by contrariness between the concept of technology and the concept of female. The first approach was criticized for biological reasoning and questionable concepts of female and male. The other approaches differ in the consideration of structural and individual aspects of women. However, they seem to represent the current research results in a more appropriate way.

In 1993, a similar survey was conducted in order to investigate the motivation and approaches of students in computer science. Table 2 shows the enrollments of the survey conducted in 1993 at the Vienna University of Technology.

At this time only two types of studies existed: computer science on the one hand and information systems on the other hand. Both studies correspond to a combination of BSc and MSc requiring a minimum duration of study of eight semesters. Table 2 shows the distribution among women and among men. In the year 2001, the bachelor studies were introduced. Computer science has been split up into five different types of studies listed in Table 1. Since 1993, the number of students in information systems dropped dramatically and was not considered in the survey in 2004 because the situation of these studies offered by three different universities in Vienna is very specific. Therefore, there are limitations when comparing the numbers of 1993 and 2004. However, both investigations yield relevant statements on Austrian computer science students in the respective period.

In the following, we describe two results, which indicate a significant change between 1993 and 2004. The first question addresses the availability of

Table 2. Enrollments of the subjects, Survey, 1993

	Females	F %	Males	M %	Sum
Computer Science	27	**64**	149	**73**	176
Information Systems	15	**36**	55	**27**	70
Sum	42	**100**	204	**100**	246

the computer (PC), as a tool broadly associated with computer science. In particular, the subjects were asked whether they had owned a computer before enrolling at the university. In 1993, 48% of the female students and 83% of the male students had owned a computer before their enrollment. In 2004, the outstanding number of 100% of the female students and 97% of the male students had already owned a computer before their enrollment. Whereas there was a significant difference in 1993, the values are nearly the same for women and men in 2004. Today having a computer of one's own seems to be an important and equally distributed precondition for students in computer science. However, the small number of women (14%) studying computer science in 2004 might be caused by this requirement. Therefore, it would be interesting to ask the pupils in Austrian schools whether they owned a computer.

The second question asks for the importance of extensive interest in computers. This question also covers the activities in leisure time. Particularly, subjects were asked whether they think interest in computers—also in leisure time—is a pre-condition for studying computer science. In 1993, 68% of the female and 73% of the male students agreed that private interest is very important. There is an explicit increase in 2004 especially in the answers of female students: 95% of the female students and 89% of the male stated this as a precondition. Although there is no significant difference between men and women, for female students the engagement with computers is nowadays much more important. Therefore, owning a computer and using it also in spare time could ease the entry into computer science, today even more than a decade ago.

FUTURE TRENDS

Austria is a fairly small country and its IT industry is not as developed and vital as in other countries. The organization of Austrian universities certainly differs from the one in other countries. It is, therefore, difficult to generalize our results of a moderate increase in female students of computer science since 1998. It seems to be plausible that the Austrian trend is at least partly due to specific conditions like, (e.g., the introduction of the bachelor studies). It would be valuable to compare our results with data from several other countries to find out whether the trend we describe is a general international trend or a specific Austrian phenomenon.

CONCLUSION

The under representation of women in computer science seems to be quite a complex phenomenon. Many different reasons have been offered to explain the lack of participation of women in computing but we still do not know enough about the relative importance of these reasons. In Austria, some of the explanations given for the under-representation of women in computer science do not hold anymore, as, for example, lack of access to computer technology. Our own questionnaire and the micro census data both indicate that there is a tendency to more equal access among younger age groups. The future will show whether these changes will lead to a higher percentage of female students of computer science in the long run.

Another problem is the bachelor studies with a high percentage of female students. Women apparently feel attracted by media informatics and medical computer science and deterred by computer engineering and information and software engineering. This conforms to general stereotypes. From a feminist point of view, the introduction of subjects like medical computer science is contradictory because on the one hand, it attracts women to computer science but on the other hand, it reinforces gender differences.

The higher demand for (female) IT specialists is also difficult to interpret. It is highly probable that this demand will fluctuate in the future in accordance with the development of the economy. Consequently, the proportion of female IT specialists will probably fluctuate as well. Again, it is an open question whether there will be an increase in female IT specialists in the long run.

In general, there is some empirical evidence that in Austria the situation for female computer scientists is improving but that this development is not unequivocal. Only long-term experience can show whether this trend will be only temporary or not.

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KEY TERMS

BSc: Bachelor Studies in Austria are characterized by a duration of six semesters and require general qualification for university entrance (Matura). Graduates receive the degree Bakkalaurus/ Bakkalaurea (Bakk.).

Coeducation: Coeducation is the education of both sexes in the same institution. It is supposed to be beneficial for the equality of women and men. There is some empirical evidence, however, that at least in some subjects, it might be better to have single-sex classes, so that female students get more attention than they get in mixed classes.

Computer Science (at Austrian Universities): A general label for academic studies in theoretical informatics, human-computer interaction, computer and software engineering and similar subjects.

Media Informatics: Media Informatics is a sub-discipline of Computer Science, which deals with all aspects of multimedia systems (technological and programming aspects, design, usability).

Medical Computer Science: A sub-discipline of Computer Science, which deals with applications in medicine.

Mentoring: Mentoring means providing support, counsel, friendship and constructive example. In the context of universities, mentors could be professors but also advanced students. Mentors for female students are necessary because they get less feedback and encouragement than their male counterparts and are not integrated into networks of students.

MSc: Austrian Masters' Studies are either a full study (10 semesters with the BSc included) or graduate studies (4 semesters). Graduates receive the degree Dipl.-Ing.

New Economy: Small and innovative companies which deal with all kinds of information technology form a sector of the economy. This sector might be called New Economy. It has been claimed that the organizational structure of these companies and their business strategies are fundamentally different to more traditional sectors.

NOTE

Part of this work was done while the author was an ERCIM Research Fellow at IDI, Norwegian University of Science and Technology (NTNU), Trondheim, Norway.

Participation of Women in Information Technology

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INTRODUCTION

Our nation's continued global competitiveness is widely believed to depend upon the United States maintaining its leadership in the development and management of new information technologies (Freeman & Aspray, 1999; Malcom, Babco, Teich, Jesse, Campbell, & Bell, 2005; Sargent, 2004). Rapidly changing technologies have pervaded every sector of American society, infusing nearly everyone's work and personal lives. Over the long term, we may face a shortage of highly educated IT workers who are needed to maintain and increase the economic productivity of the United States. Interestingly, according to Freeman and Aspray, if women were represented in the IT workforce in equal proportion to men (assuming the percentage of men in IT vis-à-vis other professions remained constant), this impending shortage and its potentially economically devastating consequences could be prevented.

We identify the pipeline of potential female IT workers as beginning in the middle grades, with the girls who take college-prep algebra by the eighth grade and elect college-bound courses in math, science, and computer science through high school. These girls are then prepared to complete a bachelor of science degree in computer science, computer engineering, or electrical engineering and become creative future IT workers.

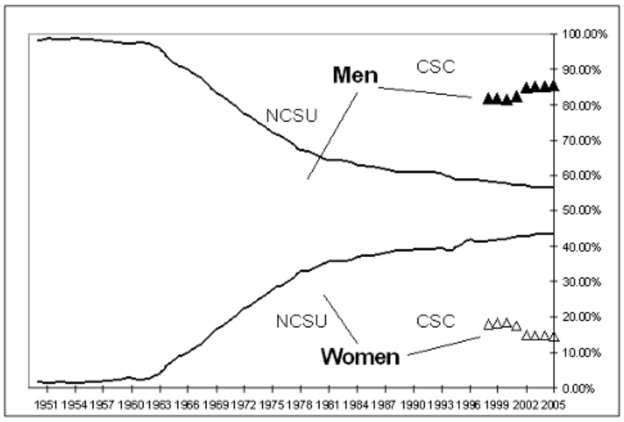
In this article, we examine some of the factors that, as suggested by the literature, influence the low participation of women in IT. We also discuss the open research issues in understanding and modeling the (educational) persistence of young women in IT-related disciplines, and we outline some results from Girls on Track, an intervention program for middle-school girls. We end with some suggestions for making IT more appealing to this currently underrepresented population.

BACKGROUND

While the enrollment of girls in advanced science and mathematics courses in high school continues to increase, their enrollment in high-school computer-science courses is extremely low (Congressional Commission on the Advancement of Women and Minorities in Science, Engineering and Technology Development [CCAWM], 2000). With women's increased participation in advanced high-school mathematics and science, the achievement gap is closing between men and women (National Science Board, 2000). However, our research seems to indicate that these academic gains may not translate into future career gains in IT.

In the later stages of this pipeline, undergraduate women continue to be underrepresented in computer-science, electrical-engineering, and computer-engineering majors (American Association of Undergraduate Women's [AAUW's] Educational Foundation, 2000; Vesgo, 2005). While in recent years, women's representation in the U.S. undergraduate population has risen to more than 50%, their overall numbers in computer-science programs have in fact declined (Freeman & Aspray, 1999; Vesgo, 2005). Figure 1 illustrates this trend using publicly available North Carolina State University (NCSU, 2005) data.

Figure 1. Recent gender trends at an engineering school (CSC=computer science)



The National Science Foundation (NSF, 2000) has identified several related issues.

- Women are prevalent in fields such as psychology and biology.
- Women are less likely to choose science and engineering.
- Women are more likely to work part time.
- Women holding doctorates in science or engineering are less likely to be tenured or to hold the rank of full professors at educational institutions.
- Women scientists and engineers tend to receive lower salaries.

Positive developments are that the number of bachelor's degrees earned by women in all major science and engineering fields, except mathematics and computer science, are increasing, and the number of younger women engineers in management positions seems to be increasing as well (NSF, 2000).

On the other hand, the number of undergraduates seeking computer-science degrees is down sharply since 2000, and the percentage of women has also declined (Malcom et al., 2005; Vesgo, 2005; Zweben, 2005).

Hence, we continue to be concerned with the declining numbers of women in computer science, particularly as many researchers have reported that this problem has roots in girls' decisions, dispositions, and experiences as early as elementary school.

We now focus on these trajectories of personal and academic development among college-bound females aged 12 to 20. In this context, the term college bound implies middle-grade students that take algebra by the eighth grade, achieve in the top third of their class, and have a predisposition and preparation to take calculus later in their studies.

Underrepresentation of Females in Information Technology Fields

Women's underrepresentation in science, engineering, mathematics, and technology courses and careers has been studied extensively (e.g., AAUW's Educational Foundation, 2000; Malcom et al., 2005; Vesgo, 2005). While the achievement gap in mathematics and science is closing as more women select advanced courses in high-school science and mathematics (National Science Board, 2000), the enrollment of young women in CSC courses and advanced-placement classes in high school continue to remain low (AAUW's Educational Foundation).

A number of hypotheses have been generated to explain the declining enrollment of women in CSC as a function of girls' experiences from ages 12 to 18. For example, Freeman and Aspray (1999) cited the following issues.

- Lack of appropriate equipment in high school
- Lack of computer experiences
- Nature of computer games
- Lack of career guidance
- Perception of competitive environment
- Gender differences in socialization
- Perception of solitary occupation, requiring long hours in unsafe working environments
- Lack of women role models

We add to this the possibility of a very strong influence of parents of the girls (Berenson, Howe, & Vouk, 2005). These hypotheses are supported by an ethnographic study of 20 female CSC undergraduates that found that prior class experiences, as well as interest in computers and the promise of the field, were primary motivators for majoring in CSC (Margolis & Fisher, 2001).

Personal Factors

Previous research by Kerr (1997) sought to identify common patterns in attitude change among early adolescent girls and how these changes could affect the girls' achievement and motivation. In 1991, the AAUW conducted a landmark study documenting a steep decline in self-esteem among Caucasian adolescent girls, with a lesser decline for African-American girls. Other findings indicated a circular relationship among girls who enjoyed mathematics and science in that they had higher self-esteem and aspirations. Conversely, girls who had higher aspirations enjoyed mathematics and science. Family and school had a greater impact on self-esteem than the peer group (AAUW, 1991). Kerr noted that "pride in schoolwork, the belief that one is able to do many things well, and the feeling of being important in one's own family were the major contributors to self-esteem in this study" (p. 169).

Adolescent Girls

In elementary school, gifted girls demonstrate excellent social knowledge and achieve better grades than gifted boys (Kerr, 1997). By high school, however, while girls continued to attain high grades and were highly involved in extracurricular activities, many took less rigorous courses and suffered declines in their IQs (intelligence quotients), self-esteem, and confidence. Researchers have reported conflicts between conformity and achievement among gifted high-school girls (e.g., Arnot, David, & Weiner, 1999). Kerr reported that, throughout adolescence, girls tend to lower their expectations, choosing moderate over high prestige careers, attending less selective postsecondary institutions, and dropping out of graduate programs and professional training more often than men.

Parents, Teachers, and Mentors

Evidence exists that some teachers and parents have different expectations for girls and boys, and these expectations can impact children's achievement (e.g., Leder, 1992). While Lareau (1992) noted that mothers bear primary responsibility for their children in schools, Stevenson and Baker (1987) found that a majority of mothers spend more time and effort in helping their sons with schoolwork and are less likely to accept poor grades from their sons than their daughters. Hanna, Kundiger, and Larouche (1988) found that countries with high support for learning mathematics had fewer gender differences in achievement, but that in countries with low support for learning mathematics, the achievement gap increased in favor of males.

MODELING EDUCATIONAL PERSISTENCE INTO IT CAREERS

A general open issue is modeling educational persistence leading to undergraduate study in IT careers among young women who take college-prep algebra by eighth grade. Some specific issues include the following.

- Identification of school, social, and personal factors associated with young women's decisions to pursue and persist in undergraduate study in IT fields
- Creation and testing of models using the above factors to predict young women's decisions to pursue and persist in IT undergraduate study
- Development of appropriate tools and interventions to increase young women's interest in IT careers based on the Women in Information Technology (WIT) model

Approach and GoT Activities

From 1999 to 2003, NSF funded Girls on Track (GoT; NSF 9813902) to provide a year-round enrichment program for more than 200 talented girls in Grades 7 and 8 who were selected to take Algebra I on the fast track. The project has been so successful that the GoT camp still runs every summer. All GoT information and deliverables are online at http://ontrack.ncsu.edu.

The ages of the girls in GoT range from 11 to 13, with 60 to 65% of them being Caucasian, 25 to 30% being African American, and 10% being Asian. The girls attend a 2-week summer camp where they investigate community problems using mathematics and information technologies. In addition, girls in the program may receive tutoring in the fall and math mentoring in the spring. In the first few years, GoT also incorporated a professional-development component for middle-school math teachers, preservice teachers, and guidance counselors. As part of GoT and WIT (NSF 0204222), we have collected 7 years of quantitative and qualitative data from these girls, teachers, counselors, and parents. We are currently building models to assess and predict the factors that influence the decisions of our participants to pursue IT careers.

Types of quantitative data about the girls over time include standardized test results in mathematics and computer literacy; mathematics, science, and computer-science course selections; confidence in mathematics and information technologies; proportional reasoning scores; and career interests. Qualitative data include individual interviews, reflections, Web pages, and focus-group discussions. Additionally, data were collected from camp counselors and parents.

Completed analyses disclose several interesting findings. First, the data still indicate that proportional reasoning appears to be an important indicator of success in Algebra I for these talented girls. Overall, the correlation between proportional-reasoning scores and the aptitude and achievement scores seems to indicate that an understanding of proportional reasoning is an important contributor in both standardized measures of aptitude and achievement for Algebra I and for staying on track in math.

Another finding is that, although the girls enjoyed working with information technologies, many of them had not had extensive prior experience using IT tools. Before coming to the GoT summer camp, many girls did not use IT for academic purposes. For example, 82% percent of the Year 2 girls had either rarely or never used a spreadsheet. Similarly, 65% of these girls had rarely or never used IT tools to solve math or science problems. During the camp, girls were given opportunities to use the Internet and spreadsheets to investigate and research community problems. They created graphs, Web pages, and PowerPoint presentations to showcase their findings to parents, camp counselors, and other girls. In their postcamp surveys, 100% of the girls rated their PowerPoint experiences positively, and 96% rated their Web-page construction positively. Prior to Girls on Track, girls tended to use the Web often, but in service of personal rather than scholarly interests.

In terms of mathematics attitudes, survey results for the girls from the first 3 years of camp reported high or very high levels of confidence in their abilities to do math-related activities. A postcamp survey highlighted that for Year 2 girls, 93% acknowledged that Girls on Track helped them "understand that math is a part of everyday life." One year after camp, the Year 2 girls reported statistically significant increases in their readiness to study advanced mathematics and increased confidence in their abilities.

It should be noted that GoT subjects were turning 14, the age at which a plunge in self-confidence has been found by a number of researchers. In terms of career choices, 66% of the Year 1 (1999) girls planned on entering math- or science-related careers. For Year 2 girls, survey results indicated that 81% of these girls expressed interest in working with computers and mathematics in their future careers. During the camp, they were given the opportunity to examine the relationship between various careers, salaries, and the mathematics needed to succeed in those careers. Over half of the girls agreed that the program helped them to "think of new ideas about careers, especially with technology." Results were similar for Year 3 girls. Unfortunately, recent telephone interviews indicate that most of the girls that are on track with respect to algebra are not thinking of continuing in IT careers (Berenson et al., 2005). We suspect that one of the reasons could well be the way we teach and deliver technology in schools and colleges.

Information Technology

What can be done about the issue? The next generation of IT users should, and do, expect not only the provision of effective, high-quality computing engines, but also equally good educational, training, and outreach (ETO) services. These diverse users will require differentiated support that is smoothly integrated with advanced computational and networking frameworks, and with the users' day-to-day operations. Next-generation users (including students and teachers) expect IT to come to them in the form of an appliance or service that aids their work flows (e.g., computational genetics, or the provision of state-of-the-art training in a remote school) rather than hampers them with excessive overhead.

Unfortunately, the seamless and widespread integration of new technologies into everyday operational and educational work flows is still to come. The situation is particularly acute in the following areas.

a. In very rapidly moving fields, such as bio and medical sciences, where users must keep pace with both rapid advances in their own field and the latest developments in computing and networking. These users often suffer from technological overload and ETO-service deficiency.
b. In the case of groups that are traditionally underrepresented in IT, for whom technological and ETO obstacles are exacerbated by economic, social, and other factors (e.g., women, minorities, rural school districts, smaller universities). These groups face a daunting catch-up task at best, and a continuously widening and dangerous technological and skills gap, with all that it implies, at worst.

What is needed is the development of methods and approaches for effectively reaching communities at technological risk, especially those concerned with math and sciences education, via facilitation, mentoring, and training programs. We saw the GoT effort as a major opportunity for the exploration and piloting of IT appliances for (a) the teaching of math and sciences and (b) the on-track steering and retention of underrepresented student populations in IT. We see WIT as doing that by assessing methods for the following.

1. Reducing the technological overload through the introduction of appliance-like high-technology solutions that enhance user activities and allow users to concentrate on their work flows
2. Promoting and increasing exposure to state-of-the-art ETO services in appropriate communities

An appliance-like solution does not mean just technological leveling of the field, but also the development of community- and group-appropriate pedagogical, training, and social interventions that increase the technological awareness of the community, reduce its aversion to technological change, ease that change, and advance its workforce into a state where it can sustain an influx of innovation through a combination of stable remote and local resources. This means easier access to state-of-the-art equipment (through network-based solutions), a better trained and continuously upgraded local instruction cadre, and an active technology assistance program that makes new technologies readily accessible and a source of eager anticipation rather than frustration for both teachers and students.

In addition to making IT more accessible, it is also important to involve young children in understanding and exploring the uses of IT for careers and real applications, and to carry this emphasis through the college level. We may also need to involve both parents and counselors early on to engage and interest girls in IT.

FUTURE TRENDS

As indicated by Blum and Frieze (2005) in their analysis of women in computer science at Carnegie Melon, the field of IT itself changes as the population of IT workers changes. Highlighted differences between men and women, such as choice of topic for study, are diminished when the number of women passes a certain threshold. When the workforce becomes more balanced, it is easier to recruit women, and opportunities for leadership and full participation become much more available (Blum & Frieze; Cohoon, in press). We also foresee that this broadening of participation will introduce new innovations and improved working conditions for all IT workers (CCAWM, 2000).

CONCLUSION

Although the demand for IT jobs continues to grow, the percentage of women in IT-related fields continues to decline. Some of the possible reasons for this decline include gender socialization, a lack of experience with and access to computers, a lack of career guidance, and perceptions of IT through the nature of computer games and work environments.

Findings from our Girls on Track and Women in Technology programs indicate that parental influence may also be a very strong factor in girls' career choices. We find it disconcerting that even girls who are excellent in math may not choose to enter IT careers. To address these issues, we believe it is important to make IT more accessible and to involve young children and their parents, teachers, and counselors early in the discovery of what makes IT exciting and useful.

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KEY TERMS

ETO Services: Educational, training, and outreach services. IT used for these services is often the only exposure that underrepresented populations may have to computers and IT.

Girls on Track: An intervention program designed to keep talented middle-school girls on the "fast math track." (http://ontrack.ncsu.edu)

IT Appliance: Software that can be readily used by novices in a natural way, without technical training, much like a refrigerator or toaster.

IT Career: A career requiring an electrical-engineering, computer-science, or computer-engineering degree. Emphasis is placed on technical and creative roles rather than support roles.

Network-Based Education: The use of tools over a network for education and training.

Pipeline: It identifies sources of potential IT workers, including preparatory courses such as algebra and calculus. Particular focus is paid to places and issues where people, and particularly women, leave the pipeline, such as the choice of less advanced math classes in high school.

Women in Technology (WIT): A longitudinal study of the Girls on Track program designed to model the educational persistence of young women in IT-related fields. (http://wit.ncsu.edu)

P

Personality Characteristics of Established IT Professionals I: Big Five Personality Characteristics

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INTRODUCTION

Women are under represented in the information technology (IT) workforce relative to the overall labor force, comprising about 35% of the IT workforce and 45% of the overall labor force (Information Technology Association of America, 2003). A basic question to be addressed is whether this under representation is a function of barriers to employment of women in this career field, or a function of career-related choices that a majority of women make during their lives. The research reported here is part of a series of studies attempting to better understand the reasons underlying this under representation of women in this reasonably lucrative profession. Through a grant provided by the National Science Foundation (NSF 29560) and in partnership with Consulting Psychologists Press, we have been able to design and conduct an extensive survey of professional workers, IT professionals and a comparable set of non- IT professionals. The non-IT professionals included individuals who are similar to the IT sample in terms of education level (but not specific degree fields) and who work in jobs with comparable human attribute demands, including written comprehension, oral comprehension, oral expression, written expression and deductive reasoning. The survey items include measures of Big Five personality constructs (NEOAC) and Core Self-Evaluations (CSE). The purpose of this article is to document similarities and differences between established IT and non-IT professionals and between males and females on these variables, thereby establishing a benchmark for comparisons with future samples of IT professionals.

Why is this worth doing? Because in the last decade of the 20th century, a critical mass of knowledge related to personality in work organizations has developed. Personality contributes to all that happens during a person's career, and informs our understanding of things like work motivation, job attitudes, citizenship behavior, leadership, teamwork, well-being and organizational culture. Increasingly, we have realized that personality plays an important role in determining who is hired and fired (see Schneider & Smith, 2004).

BACKGROUND

The Survey Sample

Data were obtained from individuals who voluntarily responded to an online survey prepared and managed by the Policy Research Institute at the University of Kansas between December 2003 and September 2004. Participation in the survey was solicited from employees at several large organizations with offices in the central United States (U.S.), and from business school and computer science alumni of a large mid-western university. Note that this business school offers several management information systems (MIS) courses.

Each survey respondent was asked to indicate his or her current career field (one of 13 categories or "Other") and specific job title (open-ended). The researchers used this information to classify respondents as either an IT or non-IT professional. The sample consists of 703 working professionals who completed the survey. Seventy-three percent (510) are non-IT professionals; 27% (193) are IT professionals. Fifty-eight percent (405) are male; 42% (298) are female. The non-IT professionals include accountants, auditors, CEOs, CFOs, presidents, consultants, engineers, managers, administrators, management analysts, scientists, technicians, nurses, teachers and so forth. The IT professionals include application developers, programmers, software engineers, database administrators, systems analysts, Web administrators and Web developers.

Respondent Demographic Information

Table 1 shows means and standard deviations on several demographic variables for the sample.

The age range of the respondents is 22 to 70 years. The mean age is 38.7 years, with a standard deviation of 9.8. Twenty-two percent of the respondents are in their 20s, 33% in their 30s, 30% in their 40s, 13% in their 50s, and 2% are 60 years of age or older. On average, IT respondents are 1.8 years older than non-IT respondents.

The respondents are highly educated. Ninety-three percent hold 4-year college degrees, and 45% have graduate school degrees. Six percent have some college, and less than 1% report having only completed high school. Mean years of formal education is 16.8, with a standard deviation of 1.5. On average, the non-IT respondents have 0.8 year more formal education than the IT respondents.

IT professionals in the sample report having worked for pay 20.1 years on average, almost 2 years more than the non-IT professionals. This is consistent with the average age of the IT respondents being almost 2 years older than that of the non-IT respondents. The IT professionals report having worked in their current career field 13.8 years on average, 3 years more than the non-IT professionals. Respondents report having worked for their current employer for an average of 7 years (standard deviation = 6.5 years), and having held their current positions for an average of 4.3 years (standard deviation = 4.4 years). They report having held an average of 3.3 jobs in their current career field (standard deviation = 2.2).

Male respondents report being exposed to computers an average of 1.6 years earlier than female respondents (at 15.4 vs. 17.0 years of age). The majority (55%) took no computer science courses in high school, 21% took one computer science course,

Table 1. Demographic information for the professional worker sample (NEOAC & CSE)

	Means (top) and Standard Deviations (bottom)								
Demographic Variable	**Total Sample N = 703**	**Non-IT N = 510**	**IT N = 193**	**Male N = 405**	**Female N = 298**	**Non-IT Male N = 273**	**Non-IT Female N = 237**	**IT Male N = 132**	**IT Female N = 61**
Age	38.7 9.8	38.2 9.7	40.0 10.0	38.6 9.8	38.9 9.8	38.3 9.7	38.1 9.8	39.2 10.2	41.8 9.3
Years of formal education	16.8 1.5	17.0 1.4	16.2 1.5	16.9 1.4	16.6 1.5	17.3 1.2	16.8 1.5	16.2 1.6	16.0 1.3
Years worked for pay	18.7 9.5	18.2 9.4	20.1 9.7	18.7 9.7	18.6 9.2	18.3 9.6	18.0 9.1	19.6 9.9	21.1 9.2
Years in current career field	11.6 8.1	10.8 7.8	13.8 8.6	11.8 8.2	11.4 8.1	11.0 7.9	10.4 7.6	13.3 8.4	15.1 8.7
Years with current employer	7.0 6.5	6.8 6.6	7.5 6.3	7.0 6.4	7.1 6.8	6.9 6.5	6.8 6.8	7.1 6.2	8.3 6.4
Years in current position	4.3 4.4	4.2 4.4	4.6 4.3	4.4 4.5	4.1 4.2	4.4 4.7	3.9 4.1	4.4 4.2	5.2 4.6
Number of jobs held in current career field	3.3 2.2	3.2 2.2	3.4 2.3	3.2 2.3	3.3 2.1	3.2 2.3	3.2 2.1	3.3 2.3	3.7 2.2
Age first exposed to computers	16.1 6.8	16.2 7.0	15.9 6.4	15.4 6.2	17.0 7.5	15.6 6.3	16.8 7.8	15.0 6.1	17.8 6.5
Number of computer science courses taken in high school	0.8 1.2	0.8 1.1	0.9 1.3	0.9 1.2	0.7 1.1	0.9 1.2	0.7 1.0	0.9 1.2	0.7 1.4
Number of computer science courses taken in college	5.3 7.1	3.5 5.3	10.1 9.1	6.2 8.0	4.0 5.6	4.2 6.1	2.6 3.9	10.5 9.6	9.1 7.8

15% took two, and less than 10% report taking three or more computer science courses in high school.

Differences show up in terms of the number of computer science courses taken in college. The total sample mean is 5.3 courses with a standard deviation of 7.1, indicating substantial variability. IT professionals took an average of 10.1 computer science courses, while non-IT professionals took 3.5 computer science courses in college. Males took 6.2 computer science courses in college, while females took an average of 4.0 computer science courses.

The Big Five Personality Constructs

During the 1980s, after some four to five decades of research, development and elaboration, the five factor model (FFM) of personality—also called the "Big Five" model—was recognized as representing the five most basic dimensions underlying the traits identified in both natural languages and psychological questionnaires (Digman, 1990). Essentially, five synonym clusters appear to account for the majority of differences between individual personalities. These five personality traits reflect the physiological activities of different underlying arousal systems, and represent predispositions to behave in certain ways when in the presence of particular stimuli (Howard & Howard, 2001). The five traits of this model are explained briefly in the following paragraphs. These descriptions are paraphrased largely from Howard and Howard (2001), because their descriptions use less psychological terminology and are more accessible to the broader spectrum of working professionals.

Factor N, or Neuroticism, refers to one's need for stability. A person high in N is very reactive and prefers a stress-free work environment. A person low in N is typically very calm and relatively unaffected by stress that might result in ineffective behavior in others. In general, women score higher than men on measures of N.

Factor E, or Extraversion, refers to one's positive emotionality or sociability. A person high in E likes to be in the thick of the action, typically interacting with other people, while a person low in E likes to be away from the noise and hubbub, crowds and so forth. In general, there are no systematic differences between women and men on measures of E.

Factor O, or Openness to Experience, refers to one's originality or imagination. A person scoring high in O has a voracious appetite for new ideas and activities, and is easily bored with routine or highly familiar situations. A person low in O prefers familiar territory and tends to be more practical, conventional and conservative. In general, there are no systematic differences between women and men on measures of O.

Factor A, or Agreeableness, refers to one's accommodation or adaptability. A person high in A tends to accommodate or adapt to the wishes and needs of others, and is often viewed as cooperative. A person low in A tends to focus on his or her own personal needs and priorities, and is often described as competitive or critical. In general, women score higher than men on measures of A.

Factor C, or Conscientiousness, refers to one's will to achieve, or consolidation. A person high in C tends to focus or consolidate his or her energy and resources on accomplishing one or more goals, and typically appears to be well organized, ambitious and strong-willed. A person low in C prefers a more spontaneous work style, is more comfortable switching from one task to another, is typically lackadaisical in working toward his or her goals, and often appears to be less organized, less punctual and so forth. In general, there are no systematic differences between women and men on measures of C.

Core Self-Evaluations

CSE is a broad personality trait that has been shown to be a significant predictor of job satisfaction and job performance (Judge, Erez, Bono, & Thoresen, 2003). It is a combination of four primary personality traits that have been featured prominently in psychological research for decades. These include *self-esteem*, the overall value one places on oneself as a person; *generalized self-efficacy*, an evaluation of how well one can perform across a variety of situations; *neuroticism* (Factor N of the Big Five), the tendency to have a negativistic cognitive/explanatory style and to focus on negative aspects of the self; and *locus of control*, beliefs about the causes of events in one's life—locus is internal when individuals see events as being contingent upon their own behavior, and external when they see events as caused largely by forces and events outside themselves and not under their control. CSE is a basic, fundamental appraisal of one's worthiness, effectiveness and capability as a person. Individuals high in CSE are generally more satisfied with their jobs, their work and their lives than are individuals low in CSE. Individuals high in CSE also tend to perform their work and their jobs better than those low in CSE. Judge, Erez, Bono, and Thoresen (2003) have suggested that existing measures of Neuroticism are too narrow to capture self-evaluations, perhaps due to the origin of Neuroticism measures in psychopathology, and hence appear to be less valid predictors of work-related outcomes as compared to CSE. Judge and his colleagues have developed and convincingly demonstrated both the reliability and multi-faceted construct validity of a 12-item direct measure of CSE—the *Core Self-Evaluations Scale* (CSES). There are no systematic differences between women and men on this measure.

COMPARISON OF IT AND NON-IT MALE AND FEMALE PROFESSIONALS ON BIG FIVE AND CSE PERSONALITY VARIABLES

Table 2 contains the means and standard deviations for 273 non-IT males, 237 non-IT females, 132 IT males and 61 non-IT females on measures of N, E, O, A, C and CSE. The results are expressed in standardized score (T-score) format where the norm group mean = 50 and the norm group standard deviation = 10. The measures of N, E, O, A and C are derived from the 12-item scales of the NEO Five Factor Inventory (NEO-FFI), and standardized using combined gender norms derived from a sample of 500 men and 500 women selected in a stratified manner designed to match U.S. census projections for 1995 in the distribution of age and race groups (Costa & McCrae, 1992). The measure of CSE is the 12-item CSES mentioned above, standardized using norms derived from four different samples yielding CSES results on 841 individuals (Judge et al., 2003).

Table 2 also contains the results of a two-factor (gender X career field) analysis of variance used to test for significant differences in the personality variables as a function of gender (Male/Female), career field (IT/non-IT) and the interaction of gender and career field. This analysis reveals whether there are differences on the respective personality variables between males and females in the total sample (gender effect) and between IT and non-IT professional workers (career field effect), and whether there is an interaction effect (gender by career field interaction) indicating that males or females within either IT or non-IT are different from male and female professional workers in general.

Table 2. Big Five and Core Self-Evaluations personality scale results by gender (M/F) and career field (IT/Non-IT)

	Means (top) and Standard Deviations (bottom)				**Two Factor ANOVA Results Effects (p < .05)**		
	Non-IT Career Field		**IT Career Field**				
Personality Construct	**Male N = 273**	**Female N = 237**	**Male N = 132**	**Female N = 61**	**Gender**	**Career Field**	**Gender by Career Field Interaction**
N Neuroticism	45.8^{a} 10.9	49.2^{b} 11.0	46.4^{ab} 9.1	48.7^{ab} 11.3	Yes	No	No
E Extraversion	55.3 10.7	55.5 11.0	50.6^{a} 10.6	56.5 11.2	Yes	Marginal	**Yes**
O Openness to Experience	52.1^{ab} 11.0	51.9^{a} 11.4	55.0^{b} 10.7	53.9^{ab} 10.3	No	Yes	No
A Agreeableness	48.4^{a} 11.2	52.6^{b} 10.7	48.3^{a} 11.1	52.3^{ab} 11.5	Yes	No	No
C Conscientiousness	52.2^{a} 9.9	54.5^{b} 10.3	49.6^{a} 9.6	53.4^{ab} 10.5	Yes	Yes	No
CSE Core Self-Evaluations	48.6 10.8	47.4 10.5	47.3 8.6	47.5 11.4	No	No	No

[ab]Means in each row with common superscripts are **not** reliably different from each other.

There is an overall gender effect for N. Females score higher on Neuroticism than males, a common finding for this personality construct. There is neither a career field effect nor an interaction effect for N. IT professionals are similar to non-IT professionals in the need for stability.

For E there is a gender effect, a marginal career field effect and a gender-by-career field interaction effect. The Extraversion mean for IT males is about one-half standard deviation lower than those for IT females, non-IT females and non-IT males. While IT females are significantly more extraverted than IT males, IT females are similar in Extraversion to non-IT male and female professionals. IT males are different—lower—in Extraversion compared to other professional workers, including IT females.

For O there is a career field effect. On average, IT professionals score higher on Openness to Experience than do non-IT professionals, indicating that they are somewhat more original and imaginative, and probably more easily bored. There are no gender differences on O, and there is no interaction effect.

There is an overall gender effect for A. Females score higher on Agreeableness than males, a common finding for this personality construct, indicating that female professionals are more accommodating, helpful and cooperative than male professionals. There is neither a career field effect nor an interaction effect for A. IT professionals are similar to non-IT professionals in accommodation and adaptability.

For C there is a gender effect and a career field effect, but no interaction effect. On average, female professionals score higher on Conscientiousness than males, and non-IT professional score higher than IT professionals. Detailed analysis (post hoc comparisons of individual group means) shows that mean Conscientiousness for non-IT females is significantly higher as compared to the means for both non-IT and IT males.

For CSE, there are no differences between males and females or IT and non-IT professionals, and no interaction effect, either.

FUTURE TRENDS

For the early part of the 21st century, at least, it appears that the FFM of personality and its "Big Five" personality constructs will be the predominant broad measures of personality applied by social science practitioners in studying and helping people understand and adjust to work and other social situations (see Smith & Schneider, 2004). This article documents similarities and differences between established IT and non-IT professionals and between males and females on these variables at this point in time, and presents a benchmark against which to measure and evaluate potential changes in the future. For example, it is possible that recent trends for businesses to outsource code writing jobs may result in changes in the nature of the work of IT-professionals remaining in these businesses, leading to some different skill set requirements—possibly higher levels of problem solving or managerial skills (see Darais, Nelson, Rice, & Buche, 2004; Gallivan, 2004; Todd, McKeen, & Buche, 2004). This, in turn, could eventually be reflected in changes in broad personality characteristics of established professionals in the IT field.

CONCLUSION

In this article, we report descriptive results comparing established professionals in IT and non-IT career fields by gender on six major personality constructs. We found significant differences between IT and non-IT professionals on three of the six constructs, and significant differences between male and female professionals on four of the six constructs. However, we found significant career field by gender interaction effects for only one of the constructs.

IT professionals are higher than non-IT professionals on Openness to Experience, indicating that they are somewhat more original and imaginative, and more easily susceptible to boredom with routine.

IT professionals are lower than non-IT professionals on Extraversion, indicating that they prefer to be away from the noise, hubbub, crowds and so forth. IT professionals are also lower than non-IT professionals on Conscientiousness, indicating that they tend to be less organized, less punctual, more spontaneous and so forth.

Female professionals are higher than male professionals on Neuroticism, indicating that they are more reactive and have a stronger preference for stress-free environments. Female professionals are also higher in Extraversion, indicating stronger preferences for being in the thick of the action and interacting with others. Female professionals are higher than male professionals in Agreeableness, indicating higher levels of accommodating or adapting to the wishes and needs of others. Finally, female professionals are higher than male professionals on Conscientiousness, indicating that on average they are more organized, ambitious, goal-directed and focused.

While there are several notable personality differences between IT professionals and other professionals, and between male and female professionals, there are very few differences (only one uncovered in this study) between male and female IT professionals that do not also exist between male and female professionals in general. Males in the IT profession tend to be significantly lower in extraversion relative to females in IT and other non-IT male and female professionals. Females in IT are quite similar to other male and female professionals in terms of positive emotionality and sociability, whereas males in IT have a significantly stronger preference to be away from noise, crowds, social stimulation and so forth.

Is the nature of IT work such that individuals lower in extraversion have a significantly better chance of being successful and happy in this career field? Other research on occupational personality variables suggests that relative to other professionals, IT professionals tend to be more realistic, more investigative, less social and less enterprising, prefer to work with ideas/data/things rather than people, prefer to work alone, prefer to accomplish tasks independently and prefer to minimize risks (Ash, Rosenbloom, Coder, & DuPont, 2005). This certainly sounds like a profession dominated by individuals lower in extraversion.

These findings raise the possibility that a higher proportion of males relative to females are attracted to work in IT due to a better match of that work with personality differences underlying preferences for aspects of IT work. In general, women are more social and more cooperative relative to men, but given potential significant changes in the nature of IT work, the status of underlying broad personality characteristics of established professionals in this field may be evolving. Of course, we have examined only one aspect of the potential set of causes for the notable current difference in proportions of males and females in the IT career field, and at this point, the role of gender in career choice remains an open question.

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KEY TERMS

Agreeableness: One's accommodation or adaptability.

Conscientiousness: One's will to achieve, or consolidation.

Core Self-Evaluation (CSE): A broad personality trait that is a combination of four primary personality traits—self-esteem, generalized self-efficacy, neuroticism and locus of control.

Extraversion: One's positive emotionality or sociability.

Generalized Self-Efficacy: An evaluation of how well one can perform across a variety of situations.

Locus of Control: Beliefs about the causes of events in one's life—locus is internal when individuals see events as being contingent upon their own behavior, and external when they see events as caused largely by forces and events outside themselves and not under their control.

Neuroticism: One's need for stability.

Openness to Experience: One's originality or imagination.

Personality: A set of scores or descriptive terms that describe the individual being studied in terms of the variables or dimensions that occupy a central position within a particular theory; the most outstanding or salient impression that one creates in others.

Self Esteem: The overall value one places on oneself as a person.

Personality Characteristics of Established IT Professionals II: Occupational Personality Characteristics

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INTRODUCTION

Women are underrepresented in the information technology (IT) workforce relative to the overall labor force, comprising about 35% of the IT workforce and 45% of the overall labor force (Information Technology Association of America, 2003). A basic question to be addressed is whether this underrepresentation is a function of barriers to employment of women in this career field or a function of career-related choices that a majority of women make during their lives. The research reported here is part of a series of studies attempting to better understand the reasons underlying this underrepresentation of women in this reasonably lucrative profession. Through a grant provided by the National Science Foundation (NSF 29560) and in partnership with Consulting Psychologists Press, we have been able to design and conduct an extensive survey of professional workers, IT professionals and a comparable set of non-IT professionals. The non-IT professionals included individuals who are similar to the IT sample in terms of education level (but not specific degree fields) and who work in jobs with comparable human attribute demands, including written comprehension, oral comprehension, oral expression, written expression and deductive reasoning. The survey items include measures of occupational personality constructs (RIASEC) and *Personal Style Scales* (*PSS*). The purpose of this article is to document similarities and differences between established IT and non-IT professionals and between males and females on these variables, thereby establishing a benchmark for comparisons with future samples of IT professionals.

Why is this worth doing? Because in the last decade of the 20th century, a critical mass of knowledge related to personality in work organizations developed. Personality contributes to all that happens during a person's career, and informs our understanding of things like work motivation, job attitudes, citizenship behavior, leadership, teamwork, well-being, and organizational culture. Increasingly we have realized that personality plays an important role in determining who is hired and fired (cf. Schneider & Smith, 2004), as well as who voluntarily stays in and leaves organizations (cf. Harmon, Hansen, Borgen, & Hammer, 1994; Holland, 1997).

BACKGROUND

The Survey Sample

Data were obtained from individuals who voluntarily responded to an online survey prepared and managed by the Policy Research Institute at the University of Kansas between December 2003 and September 2004. Participation in the survey was solicited from employees at several large organizations with offices in the central United States (U.S.), and from business school and computer science alumni of a large Midwestern university. Note that this business school offers several management information systems (MIS) courses.

Each survey respondent was asked to indicate his or her current career field (one of 13 categories or "Other") and specific job title (open-ended). The researchers used this information to classify respondents as either an IT or non-IT professional. The sample consists of 523 working professionals who completed the survey and the revised *Strong Interest Inventory* (SII) (Donnay, Morris, Schaubhut, & Thompson, 2005)—the measures of occupational personality and personal style scales used in this study. Seventy-three percent (382) are non-IT professionals; 27% (141) are IT professionals. Fifty-four percent (285) are male; 46% (238) are female. The non-IT professionals include accountants, auditors, CEOs, CFOs, presidents, consultants, engineers, managers, administrators, management analysts, scientists, technicians, nurses, teachers, and so forth. The IT professionals include application developers, programmers, software engineers, database administrators, systems analysts, Web administrators, and Web developers.

Respondent Demographic Information

Table 1 shows means and standard deviations on several demographic variables for the sample.

The age range of the respondents is 22 to 70 years. The mean age is 39.3 years, with a standard deviation of 10.0. Twenty percent of the respondents are in their 20s, 33% in their 30s, 30% in their 40s, 14% in their 50s, and 3% are 60 years of age or older. On average, the IT respondents are 1.8 years older than the non-IT respondents.

The respondents are highly educated. Ninety-two percent hold 4-year college degrees, and 45% have graduate school degrees. Five percent have some college, and less than 1% report having only completed high school. Mean years of formal education is 16.8, with a standard deviation of 1.5. On average, the non-IT respondents have 1 year more formal education than the IT respondents.

IT professionals in the sample report having worked for pay 20.6 years on average, almost 2 years more than the non-IT professionals. This is consistent with the average age of the IT respondents being almost 2 years older than that of the non-IT respondents. The IT professionals report having worked in their current career field 14.2 years on average, 3 years more than the non-IT professionals.

Respondents report having worked for their current employer for an average of 7.4 years (standard deviation = 6.9 years), and having held their current positions for an average of 4.5 years (standard deviation = 4.8 years). They report having held an

Table 1. Demographic information for the professional worker sample (RIASEC & PSS)

	Means (top) and Standard Deviations (bottom)								
Demographic Variable	**Total Sample N = 523**	**Non-IT N = 382**	**IT N = 141**	**Male N = 285**	**Female N = 238**	**Non-IT Male N = 190**	**Non-IT Female N = 192**	**IT Male N = 95**	**IT Female N = 46**
Age	39.3 10.0	38.8 9.9	40.6 10.0	39.3 10.1	39.2 9.8	39.1 10.0	38.5 9.9	39.9 10.4	42.0 9.1
Years of formal education	16.8 1.5	17.1 1.5	16.1 1.5	17.0 1.5	16.6 1.6	17.4 1.3	16.7 1.6	16.2 1.6	15.8 1.2
Years worked for pay	19.2 9.7	18.7 9.6	20.6 9.8	19.4 10.1	19.0 9.2	19.0 10.0	18.5 9.2	20.3 10.1	21.0 9.2
Years in current career field	11.9 8.3	11.1 8.0	14.2 8.6	12.2 8.3	11.6 8.2	11.5 8.1	10.8 7.9	13.7 8.6	15.1 8.8
Years with current employer	7.4 6.9	7.3 7.1	7.5 6.4	7.3 6.8	7.4 7.0	7.5 7.0	7.2 7.1	7.1 6.3	8.2 6.4
Years in current position	4.5 4.8	4.4 4.9	4.7 4.5	4.6 5.1	4.3 4.4	4.8 5.5	4.0 4.3	4.2 4.3	5.5 4.9
Number of jobs held in current career field	3.3 2.3	3.2 2.2	3.5 2.4	3.3 2.3	3.3 2.2	3.3 2.2	3.2 2.2	3.4 2.5	3.7 2.2
Age first exposed to computers	16.4 7.1	16.4 7.4	16.3 6.3	15.7 6.6	17.2 7.6	15.8 6.7	17.0 8.0	15.4 6.4	18.1 5.9
Number of computer science courses taken in high school	.8 1.1	0.8 1.1	0.8 1.2	0.9 1.2	0.7 1.0	0.9 1.3	0.6 0.9	0.9 1.2	0.7 1.1
Number of computer science courses taken in college	5.0 7.2	3.2 5.1	10.0 9.5	6.0 8.3	3.8 5.3	4.0 6.2	2.5 3.4	10.3 10.3	9.4 7.7

average of 3.3 jobs in their current career field (standard deviation = 2.3).

Male respondents report being exposed to computers an average of 1.5 years earlier than female respondents (at 15.7 vs. 17.2 years of age). The majority (56%) took no computer science courses in high school, 22% took one computer science course, 14% took two, and less than 10% report taking three or more computer science courses in high school.

Differences show up in terms of the number of computer science courses taken in college. The total sample mean is 5.0 courses with a standard deviation of 7.2, indicating substantial variability. IT professionals took an average of 10.0 computer science courses, while non-IT professionals took 3.2 computer science courses in college. Males took 6.0 computer science courses in college, while females took an average of 3.8 computer science courses.

Occupational Personality and the General Occupational Theme (GOT) Scales

In 1927, E.K. Strong introduced the *Strong Vocational Interest Blank (SVIB)* (now *SII*) (Most, 1993). This measure was used to determine the degree of similarity between a person's interests and those of workers in an occupation. Strong realized in the late 1930s that a systematic clustering of the scales was necessary, but he was unable to find a system that had reliable psychometric qualities. In 1959, Holland introduced six basic occupational interest categories that closely resembled the dimensions found in research on vocational interests using the SVIB. Holland's classification system was an extension of the trait and factor theory from the 1920s and implied that the main goal of vocational counseling is to match people and jobs. In 1974, Strong's empiricism and Holland's theory were combined to develop the GOT (Harmon et al., 1994). The six vocational types of the GOT model are described below. The descriptions are paraphrased from Harmon et al. (1994) and Holland (1997).

The Realistic Theme, or R, refers to a person's preference for activities that entail the explicit, ordered or systematic manipulation of objects, tools, and machines. Realistic types enjoy jobs and activities that involve mechanical manipulations or repairs and construction. They are interested in action rather than thought and prefer concrete problems to ambiguous, abstract problems. Sample Realistic occupations include auto mechanic, gardener, plumber, and engineer.

The Investigative Theme, or I, refers to a person's preference for activities that entail the systematic or creative investigation of physical, biological, and cultural phenomena. Investigative types enjoy gathering information, uncovering new facts or theories, and analyzing and interpreting data. They prefer to rely on themselves rather than on others in a group project. Sample Investigative occupations include college professor, physician, psychologist, and chemist.

The Artistic Theme, or A, refers to a person's preference for activities that are ambiguous, free, non-systematic and that entail the manipulation of materials to create art forms or products. Artistic types have a great need for self-expression. They are also comfortable in academic or intellectual environments. Sample Artistic occupations include artist, lawyer, librarian, musician, architect, reporter and English teacher.

The Social Theme, or S, refers to a person's preference to lead others or for activities that entail the manipulation of others to inform, train, develop, cure, or enlighten. Social types enjoy working with people, sharing responsibilities, and being the center of attention. They also like to solve problems through discussions of feelings and interactions with others. Sample Social occupations include elementary school teacher, nurse, social worker, and occupational therapist.

The Enterprising Theme, or E, refers to a person's preference for activities that entail the manipulation of others to attain organizational goals or economic gain. Enterprising types seek positions of power, leadership, and status. They like to take financial risks and participate in competitive activities. Sample Enterprising occupations include traveling salesperson, buyer, realtor, sales manager, and marketing executive.

The Conventional Theme, or C, refers to a person's preference for activities that entail the explicit, ordered, systematic manipulation of data. Conventional types often enjoy mathematics and data management activities. These individuals work well in large organizations but do not show a distinct preference for or against leadership positions.

Sample Conventional occupations include bookkeeper, accountant, banker, actuary, and proofreader.

Occupational Personality and the Personal Style Scales (PSS)

The *PSS* were added to the *SII* in 1994. The *PSS* measure a person's broad styles of living, learning, playing and working. They complement the traditional vocational interest scales (i.e., RIASEC) that measure preferences for more specific aspects of the work itself. A distinguishing characteristic of the *PSS* is that they are constructed as bipolar scales, with a distinctive style (or preference) associated with both the right and left pole of each scale (Harmon et. al, 1994). There are five *PSS* attached to the *SII*: work style, learning environment, leadership style, risk-taking/adventure and team orientation. Descriptions for the first four were taken from Harmon et al., (1994).

The Work Style Scale distinguishes individuals who prefer to work with ideas, data or things (left pole or low scores) from those who prefer to work with people (right pole or high scores). The "works with people" pole links strongly to the Enterprising and Social types. The "works with ideas/data/things" pole ties strongly to the Realistic and Investigative types. Occupations whose members prefer to work with ideas, data or things include biologist, chemist and computer programmer. Occupations whose members prefer to work with people include high school counselor, flight attendant and human resources director.

The Learning Environment Scale differentiates people who prefer more practically oriented, hands-on learning situations (left pole or low scores) from those who prefer academic learning environments (right pole or high scores). Occupations whose members prefer an academic learning environment include college professor, lawyer, psychologist and physicist. Occupations whose members prefer a practical learning environment include auto mechanic, dental assistant and nurse.

The Leadership Scale contrasts those who lead by example and prefer to work alone (left pole or low score) from those who enjoy meeting, directing, persuading and leading other people (right pole or high score). Occupations whose members prefer a "leads by example" leadership style include auto mechanic, chemist, farmer and mathematician. Occupations whose members prefer a "directs others" leadership style include elected public official, minister, broadcaster and realtor.

The Risk Taking/Adventure Scale differentiates those who like to "play it safe" (left pole or low scores) from those who like to take a chance or be spontaneous (right pole or high scores). Occupations whose members prefer a "play it safe" approach include librarian, mathematician and dental hygienist. Occupations whose members prefer the "take a chance" approach include an athletic trainer, police officer and electrician.

In 2004, a new *PSS*, Team Orientation, was added to the *SII*. This construct distinguishes those who prefer to accomplish tasks independently (low scores or left pole) from those who prefer to accomplish tasks as part of a team (high score or right pole). Occupations whose members prefer to accomplish tasks independently include artist, graphic designer, medical illustrator and musician. Occupations whose members prefer to accomplish tasks as part of a team include operations manager, school administrator, sales manager, and rehabilitation counselor (Donnay, Morris, Schaubhut, & Thompson, 2005).

COMPARISON OF IT AND NON-IT MALE AND FEMALE PROFESSIONALS ON OCCUPATIONAL AND PERSONAL STYLE PERSONALITY VARIABLES

Table 2 contains the means and standard deviations for 190 non-IT males, 192 non-IT females, 95 IT males, and 46 IT females on the RIASEC occupational personality measures. The results are expressed in standardized score format (T-Scores) where the norm group mean and standard deviation are 50 and 10, respectively. The measures of R, I, A, S, E and C are derived from the 20-item scales of the *SII* and are standardized using combined gender norms derived from a sample of 9,484 men and 9,467 women (Harmon et al., 1994). Table 2 also contains the results of a two-factor (gender X career field)

Table 2. RIASEC occupational personality scale results by gender (M/F) and career field (IT/non-IT)

	Means (top) and Standard Deviations				**Two-Factor ANOVA Results Effects (p < .05)**		
	Non-IT Career Field		**IT Career Field**				
Occupational Personality Variable	**Male N = 190**	**Female N = 192**	**Male N = 95**	**Female N = 46**	**Gender**	**Career Field**	**Gender by Career Field Interaction**
R Realistic	54.8^{a} 8.4	46.6^{b} 8.2	56.2^{a} 8.5	48.8^{b} 7.9	Yes	Yes	No
I Investigative	54.0^{a} 9.2	50.7^{b} 9.7	55.1^{a} 9.3	54.7^{ab} 9.5	Yes	Yes	No
A Artistic	47.5^{a} 9.2	50.5^{b} 10.5	47.7^{ab} 9.2	51.4^{ab} 9.1	Yes	No	No
S Social	46.4^{ac} 9.1	52.3^{b} 9.4	44.2^{a} 8.9	50.0^{bc} 8.9	Yes	Yes	No
E Enterprising	51.6^{a} 10.9	52.0^{a} 10.7	44.2^{b} 9.4	46.0^{b} 10.3	No	Yes	No
C Conventional	54.2 9.6	55.0 11.2	51.8 8.3	55.8 10.1	Yes	No	No

^{abc} *Means in each row with common superscripts are* ***not*** *reliably different from each other.*

analysis of variance used to test for significant differences in the RIASEC variables as a function of gender (Male/Female), career field (IT/non-IT) and the interaction of gender and career field. This analysis reveals whether there are differences on the respective RIASEC variables between males and females in the total sample (gender effect), between IT and non-IT professional workers (career field effect), and whether there is an interaction effect (gender by career field interaction) indicating that males or females within either IT or non-IT are different from male and female professional workers in general.

There is an overall gender effect for R. Males score higher on the Realistic Theme than females, a common finding for this GOT. There is also an overall career effect for R. IT professionals scored significantly higher than non-IT professionals on the Realistic Theme. There is not an interaction effect for R.

For I there is an overall gender effect: Males scored higher on the Investigative Theme than did females. In addition, there is an overall career effect for the Investigative Theme: IT professionals scored significantly higher than non-IT professionals on I. There is not a significant interaction effect for I.

There is an overall gender effect for A: Females scored significantly higher than males on the Artistic Theme. There is neither a career effect nor an interaction effect for A.

For S there is an overall gender effect: Females scored significantly higher than males on the Social Theme. In addition, there is a career effect for S: Non-IT professionals scored significantly higher on S than did IT professionals. There is not a significant interaction effect for S.

There is an overall career effect for E: Non-IT professionals scored significantly higher on the Enterprising Theme than did IT professionals. There is not an overall gender effect or an interaction effect for E.

For C there is an overall gender effect: Females scored higher than males on the Conventional Theme. There was neither an overall career effect nor an interaction effect for C.

Table 3 contains the means and standard deviations for 190 non-IT males, 192 non-IT females, 95 IT males and 46 IT females on measures of the *PSS* of the *SII* occupational personality inventory. The results are expressed in standardized score format (T-Scores) where the norm group mean and standard deviation are 50 and 10, respectively. The

Table 3. Personal style scale results by gender (M/F) and career field (IT/non-IT)

	Means (top) and Standard Deviations				Two-Factor ANOVA Results Effects (p < .05)		
	Non-IT Career Field		IT Career Field				
Personal Style Scale	Male N = 190	Female N = 192	Male N = 95	Female N = 46	Gender	Career Field	Gender by Career Field Interaction
Work Style	44.9[a] 8.1	54.5[b] 9.2	39.8[c] 6.8	48.9 8.2	Yes	Yes	No
Learning Environment	53.9 7.6	52.2 10.4	52.3 8.0	52.5 7.8	No	No	No
Leadership	50.5[a] 9.6	50.3[a] 10.1	46.0[b] 9.4	46.5[ab] 9.0	No	Yes	No
Risk Taking	55.2[a] 8.8	47.2[b] 8.8	52.1[c] 9.3	45.1[b] 7.9	Yes	Yes	No
Team Orientation	50.0[a] 10.1	53.2[b] 9.5	48.1[a] 8.8	50.6[ab] 12.1	Yes	Yes	No

[abc] *Means in each row with common superscripts are* ***not*** *reliably different from each other.*

measures of work style, learning environment, leadership, risk taking and team orientation are derived from the 20-item scales of the *SII* and are standardized using combined gender norms derived from a sample of 9,484 men and 9,467 women (Harmon et al., 1994). Table 3 also contains the results of a two-factor (gender X career field) analysis of variance, similar to the one described for Table 2.

There is an overall gender effect for work style: Females scored substantially higher than males, meaning that in general, females prefer to work with people and men prefer with data, ideas and things. There is also a significant career effect for work style: Non-IT professionals scored substantially higher than IT professionals, meaning that non-IT professionals prefer to work with people while IT professionals prefer to work with data, ideas and things. There is not an interaction effect for work style.

For the learning environment scale, there are not any significant differences between males and females or between IT professionals and non-IT professionals.

There is an overall career effect for leadership: Non-IT professionals scored higher than IT professionals. In general, this means that non-IT professionals enjoy meeting, directing, and persuading others to a greater extent than IT professionals, who tend to prefer to lead by example and work alone. There is neither an overall effect for gender nor an interaction effect for leadership.

For risk taking, there is a significant gender effect: Males scored significantly higher than females, meaning that males in general are more likely to take risks and live spontaneously as compared to females in general. There is also an overall career field effect for risk taking: Non-IT professionals scored higher than IT professionals, meaning that non-IT professionals are somewhat more likely to take risks than are IT professionals. There is no interaction effect for risk taking.

There is an overall effect by gender for team orientation: Females scored higher than males in team orientation, meaning that females have a stronger preference than males for accomplishing tasks as a team, whereas males show a stronger preference for accomplishing tasks individually. There is also a career effect for team orientation: Non-IT professionals scored higher than IT professionals, meaning that non-IT professionals have a stronger preference for accomplishing tasks as part of a team whereas IT professionals show a stronger preference for accomplishing tasks individually.

FUTURE TRENDS

For the early part of the 21st century, at least, it appears that the GOT model, as operationalized by the *SII* with its RIASEC variables and *PSS* for measuring occupational personality, will be among the most prominent measures used by social science practitioners and career counselors in helping match people to careers and jobs they find interesting, meaningful and satisfying (cf. Donnay, Morris, Schaubhut, & Thompson, 2004; Walsh, 2004). This article documents similarities and differences between established IT and non-IT professionals and between males and females on these variables at this point in time, and presents a benchmark against which to measure and evaluate potential changes in the future. For example, it is possible that recent trends for businesses to outsource code writing jobs may result in changes in the nature of the work of IT-professionals remaining in these businesses leading to some different skill set requirements—possibly higher levels of problem solving or managerial skills (cf. Darais, Nelson, Rice & Buche, 2004; Gallivan, 2004; Todd, McKeen, & Gallupe, 1995). This, in turn, could eventually be reflected in changes in occupational personality characteristics of established professionals in the IT field.

CONCLUSION

In this article we report descriptive results comparing established professionals in IT and non-IT career fields by gender on 11 major occupational personality constructs. We found significant differences between IT and non-IT professionals on 8 of the 11 constructs, and significant differences between male and female professionals on 8 of the 11 constructs. However, we found no significant career field by gender interaction effects for any of these occupational personality constructs.

IT professionals are higher than non-IT professionals on the Realistic and the Investigative general occupational themes. This means that, in general, IT professionals have a preference for ordered and systematic manipulation of data and things, and for working on concrete (rather than ambiguous) problems. Furthermore, IT professionals have a preference for gathering information, analyzing and interpreting data, and to rely on themselves rather than on others.

IT professionals are lower than non-IT professionals on the Social occupational theme, indicating in general a lower preference for work requiring interactions and discussions. IT professionals are also lower than non-IT professionals on:

- **Work Style:** Indicating a preference for working with ideas, data, or things as opposed to people
- **Leadership:** Indicating a preference to work alone and to lead by example
- **Risk Taking:** Indicating a preference to "play it safe"
- **Team Orientation:** Indicating a preference to accomplish tasks independently.

Relative to male professionals, female professionals in general are higher on the following occupational personality constructs:

- **Artistic:** Prefer ambiguous, free, non-systematic activities
- **Social:** Prefer working with people, sharing responsibilities, having discussions and interactions with others
- **Conventional:** Prefer data management activities
- **Work Style:** Prefer working with people as opposed to ideas, data or things
- **Team Orientation:** Prefer to accomplish tasks as part of a team.

Relative to male professionals, female professionals in general are lower on the following occupational personality constructs:

- **Realistic:** Lower preference for ordered and systematic manipulation of data and things, and for working on concrete (rather than ambiguous) problems

- **Investigative:** Lower preference for systematic or creative investigation
- **Risk Taking:** Prefer to "play it safe."

While the results of this research reveal a number of notable occupational personality differences between IT professionals and other professionals, and between male and female professionals, the results also show that *there are no occupational personality differences between male and female IT professionals that do not also exist between male and female professionals in general*. This is an important finding.

The current research suggests that relative to other professionals, IT professionals tend to be more realistic, more investigative, less social, and less enterprising, prefer to work with ideas/data/things rather than people, prefer to work alone, prefer to accomplish tasks independently and prefer to minimize risks. This is consistent with other research on broad (Big Five) personality constructs, suggesting that in general the nature of IT work is such that individuals lower in extraversion have a significantly better chance of being successful and happy in the IT career field (Ash, Rosenbloom, Coder, & DuPont, 2005).

These findings raise the possibility that a higher proportion of males relative to females are attracted to work in IT due to a better match of that work with occupational personality differences underlying preferences for aspects of IT work. In general, women are more social and more cooperative relative to men. However, given potential significant changes in the nature of IT work, the status of occupational personality characteristics of established professionals in this field may be evolving. This research effort examines only one aspect of the potential set of causes for the notable current difference in proportions of males and females in the IT career field, and at this point, the role of gender in career choice remains an open question.

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KEY TERMS

Artistic: A person's preference for activities that are ambiguous, free, non-systematic and that entail the manipulation of materials to create art forms or products.

Conventional: A person's preference for activities that entail the explicit, ordered, systematic manipulation of data.

Enterprising: A person's preference for activities that entail the manipulation of others to attain organizational goals or economic gain.

General Occupational Theme (GOT): One of six broad constructs that reflect an individual's overall orientation to work (Realistic, Investigative, Artistic, Social, Enterprising, Conventional).

Investigative: A person's preference for activities that entail the systematic or creative investigation of physical, biological and cultural phenomena.

Leadership Scale: Distinguishes individuals who lead by example and prefer to work alone from those who enjoy meeting, directing, persuading and leading other people.

Learning Environment Scale: Differentiates individuals who prefer more practically oriented, hands-on learning situations from those who prefer academic learning environments.

Occupational Personality: A set of scores or descriptive terms that describe the individual being studied in terms of the variables or dimensions that occupy a central position within a particular theory of career or vocational choice; the most outstanding or salient impression that one creates in others with respect to his or her orientation to work.

Personal Style Scales (PSS): A set of scales that measure aspects of the style with which an individual likes to learn, work, assume leadership, take risks and participate as part of a team.

Realistic: A person's preference for activities that entail the explicit, ordered or systematic manipulation of objects, tool, machines and so forth.

Risk Taking/Adventure Scale: Differentiates individuals who like to "play it safe" from those who like to take a chance or be spontaneous.

Social: A person's preference to lead others or for activities that entail the manipulation of others to inform, train, develop, cure or enlighten.

Team Orientation Scale: Differentiates individuals who prefer to accomplish tasks independently from those who prefer to accomplish tasks as part of a team.

Work Style Scale: Differentiates individuals who prefer to work with ideas, data or things from those who prefer to work with people.

P

A Perspective of Equality and Role for Women in IT

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INTRODUCTION

There are many disciplines and professions where women are not well represented, are paid less than male counterparts, and rise less quickly to leadership positions. IT is one such field, encompassing a broad range of topics from software development to telecommunications. This "inequality" has created a sense of injustice among some, leading to more aggressive stands for rights, for positive discrimination, and cries for all manner of "equality" within the workplace—specifically that male and female peers are able to play the same roles and indeed should have fair opportunity to play the same roles.

This article questions the "equality" that is pursued by the "equal opportunity" agenda. In many instances demanding women, given opportunities to take traditional male dominated positions in the workplace underlines the male-dominated world, what it values, and what it requires. A worldview that rejects male domination at its core may do more to help the "equality" of women and men. Moving toward this entails (1) recognising the roles played by women in the workplace and improving remuneration—rather than forcing women to take more male orientated roles, (2) couching the well renumerated roles that males play in more female friendly language to change perceptions of who is suitable for the role, and (3) recognising the female skills that many male roles require and not failing to give women novel workplace arrangements that permit pursuing roles outside the workplace.

In each of these suggestions the importance of male and female differences are recognised. This represents an understanding of "personhood", that is, not forcing all people to be equal regardless of gender, but recognising the intrinsic worth of people above gender—and that there may be gender differences. The idea of intrinsic worth of people is based upon one theological perspective of personhood drawn from the Christian tradition. It asks for equality of personhood to be recognised over and above gender issues and gender "differences" to be actually incorporated into professional environments.

GENDER EQUALITY

Women = An Unequal Discriminated Group

Data in the 1982 and 2000 reports from the National Science Foundation of America (NSF, 1982) indicate that women are a minority group in science and engineering fields. To this we can add IT (information technology). Relatively small percentages of women earn degrees in these fields; women are more likely than men to be employed part time (if the opportunity exists) and to be unemployed. Women doctoral scientists and engineers employed in educational institutions are less likely than men to be tenured or have the rank of full professor, and women scientists and engineers receive lower salaries than men. Many other reports would reveal the same basic inequality between genders, inequality that society is increasingly unable to tolerate. There are two basic approaches we may take to this inequality.

First, we may conclude that women are not treated in the same favourable way as men and conclude that there is discrimination. We would seek to focus on strategies to restore some moral order to society that rectifies the injustice done to the female gender. For example, the UN Convention on the Elimination of All Forms of Discrimination Against Women (UN, 1979) can be understood as a statement on what the principle of gender equality of opportunity should mean. Other definitions of gender equality point to the "discrimatory" nature of inequality. For example:

Gender equality means that there is no discrimination on grounds of a person's sex in the allocation of resources or benefits, or in the access to services. Gender equality may be measured in terms of whether there is equality of opportunity, or equality of results. (www.bigpond.com.kh/users/gad/glossary/gender.htm)

Second, we may more carefully consider what equality means and what the basis of equality is; we may question whether women are discriminated against, even whether efforts to alleviate the discrimination are actually only reinforcing the problem. Another definition of gender equality states, "Gender equality means that women and men have equal conditions for realizing their full human rights and potential to contribute to national, political, economic, social and cultural development, and to benefit from the results" (www.socialpolicy.ca/g.htm). This definition is slightly improved since it focuses on realising human rights. It enables the possibility that men and women may realise those "rights" in different ways and so touches upon the main point of this article, the meaning of equality.

To some extent there has been recognition of a tendency to consider men's characteristics as the norm and women's characteristics as different from the norm, but it is not widespread. The United Nations Population Fund (UNFPA) recognises "there are differences between the roles of men and women, differences that demand different approaches" (www.unfpa.org/gender/faq_gender.htm). In many places equality is taken to be women permitted to enter the male world on a level footing; not a recognition that there are "differences". In many instances the battles fought concern arguments over women "doing the same job". All these lines of reasoning and argument implicitly force women to "be the same" as men. A more equal opportunity might be to actually create valued roles that are designed for women.

Equality Based on Personhood

The deficiency in understanding equality has largely stemmed from the corresponding focus on gender that accompanies notions of equality. This article looks at a more fundamental equality of person. The perspective resonates to some extent with the idea of human rights and that there is some more fundamental concept involved over gender, that of "being human". Equal opportunity based on personhood rather than role may sound like the antithesis to equal opportunity, based on recognising that those who can do the same job should be given the same chance. But it is an equal opportunity that would actually create roles that are perfectly suited to women, and just as valued in the workplace. It is actually based on an understanding of person that sees all people as equal, while recognising there are gender differences. These differences do not make people unequal, just different and suited to different tasks/roles. And it recognises that many workplaces are traditionally male dominated to the extent that the female role is eliminated.

The concept of equality that will be expanded here is a particular Christian perspective of personhood, in which all human beings are equal, regardless of gender, ethnic status, age, and so forth. It stems from a spiritual perspective of the person gained from Christian Scripture. Genesis 1:27 states, "So God created man in his own image, in the image of God he created him; male and female he created them." The traditional Christian belief is that all persons are equal because they are made in the divine image, which was additionally the pinnacle of creation. This image bearing reality, which all humans possess, defines our personal worth, not the role we play. It is also the basis for true equality, but equal human beings are also different because they are male and female. Thus equality should not be defined by role played, but instead on "intrinsic worth". The Christian perspective does actually go on to suggest that God gave men and women different roles to play. Some Christian perspectives (e.g., Christian feminism) argue against the interpretation of these different roles and seek to make men and women play the same role (but there are a wide variety of theologies and types of feminism within Christianity) (Australian Catholic University, 2005). In arguing against different roles, the dignity of personhood and value that comes from simply being in God's image, equal but different (Ortlund, 1995) is somehow lost.

What are some of those differences of personhood that may underpin gender differences, without undermining personhood equality? In very general terms women are more nurturing (at least many have the biological capacity to nurture developing life); they are generally more adept with language at an earlier age, more empathic, less aggressive, and are likely to create networks of support and be supportive (helping) rather than competitive. Women who have succeeded in the business world report they have qualities that are traditionally male; they are independent, "tough", and have generally fought a lone battle to achieve the role that they do play. Many women may not want to "prove" themselves in this way, especially if it means they must deny their instinctive role. They are forced to by the way the role is defined and worth perceived.

A MALE-FEMALE WORLD

When role and worth are so tightly bound together, women in male dominated fields must always play exactly the same role as men to have the same value. In many ways the equity movement supports inequity by basing worth on role and not intrinsic human value. Recognising the different roles and not making women subject to male domination is perhaps the true way to achieve equal opportunity, although it may be practically difficult if not impossible to implement. Here we outline some ways that differences in role may be accommodated in the secular workplace, enabling all persons to be equally valued.

A New World

There is almost nothing we can say within the current male-dominated worldview that would not simply support and reinforce its message. If we talked about how to encourage women into male dominated fields, we would simply be reinforcing those valued roles played by people in those fields, those desirable roles that women have been denied for a long time. We deny women the right of being valued, regardless of what they do. Certainly incentives to support women in both workplace roles and more traditional family roles come under criticism as sending the message that it is the woman's responsibility to juggle different roles, not the male's (PersonnelToday.com, 2005). Certainly there are problems when roles within and outside the workplace are valued differently. However, here we confine ourselves to roles within the workplace and make three observations:

1. Traditional women's roles in the workplace need to be valued and financially rewarded. Often the workplace values technical roles more highly than administrative roles. It is not necessarily the case that the technical role requires more skill, just different skills, skills that women may be more suited for. The existing roles that attract the most prestige, financial advantage, and respect do not need to be male roles. Forcing women into male roles, rather than addressing the under-valuing that occurs in women's roles, does not address the need to base equality on personhood and intrinsic worth.
2. Most roles within the workforce are framed in such a way as to make men the most suitable candidates. Tasks are often defined in male terms (e.g., "provide leadership" rather than "nurture and facilitate growth"). Traditional male roles in the workplace need to be described and considered in female terms. This may genuinely open the door for female candidates to undertake a job, appropriate to their skills, while not forcing women into roles that may be more suited to men because of the job description.
3. New non-stereotypical, complimentary roles for people in the workforce need to be considered and male roles augmented with skills that women inherently own. For example, the technical world is realising that while computer programming skills may be useful, communication is equally important in a team-oriented workplace. Traditional male roles augmented with these other skills may open up avenues for women.

These three observations are expanded more fully in the following chapters. In each case there is a call to value the intrinsic worth of a person, while respecting that there are differences between people created by gender, differences that may controversially influence the task performance or preference.

Financially Rewarding Traditional Female Roles

Where women are contributing to the paid workforce, the tasks they do are often less valued than those men do. For example, the workplace often values technical roles more highly than administrative roles; universities value research more than teaching. In Australia the Premier's Department on Remuneration and Work found that (end 1999) "over the whole public sector, the average female full-time equivalent remuneration rate ($42,613 p.a.) was 8.6 % lower than the average rate for males ($46,619)" (http://rrd.premiers.nsw.gov.au/rrd/public/1999/remun.html). There are numerous instances where females could receive better remuneration but do not. This situation represents a failure to recognise the intrinsic worth of a person and starts to rate some skills as more desirable than others. It is at the root of the problem of a technological 'modern' society where productivity and economics is primary.

Changing the Language of Males Roles

Many traditional male roles are described in male language, emphasising the traditional male qualities and minimising the (traditional) female aspects required in a certain role. Simply describing positions in more female-friendly language has lots of potential to make women (and others) change their perceptions of the task—and hence who is appropriate for the role. Female-friendly language, acknowledging female-friendly roles within an organisation, would do females more justice since it would no longer hide the fact that women's qualities are actually needed. (The alternative is for the woman to mould herself to fit with the male stereotype and perpetuate the male worldview.) Changing a job description would not revolutionise the world overnight, but it would start to shift perceptions; it would identify roles women must play, qualities (typically female) needed and valued at the very top of an organisation (and indeed, all through it). The first step in changing a self-perpetuating male dominated world is to accurately describe the roles. This will cause a shift in perceptions of who is appropriate for the job.

For example, the description of specific duties at the professoriate level at the University of South Australia include: "*fostering* the research of other groups and individuals within the unit, playing an *active* role in the maintenance of academic standards and participating in and providing *leadership* in community affairs". Such descriptions actually call for roles that women traditionally play, often more frequently than men but this is hidden in the language used. A quiet, young woman is highly unlikely to be seen as suitable professor material. Language in job descriptions tends to value males and male traits, and indeed creates a situation where only a male is seen as suitable for fulfilling certain roles; whereas in reality a female may actually be what the organisation is looking for. In the previous example the words "leadership", "active", and "foster" colour perceptions of what is required and who is suitable.

First, the candidate must provide "leadership" in the community. The young woman is probably not going to be regarded as providing traditional male leadership (which at its worst dominates, forces its agenda, and imposes). However, she could be perceived as *supporting*, *working with*, *helping, co-operating with,* and *building*. Describing the role as "*service* to the community" or "*support* of community building activities", or "*cooperation* with community" may radically change the perception of whether the young female candidate is suitable for the job or not. Using language of a male-dominated world would make her seem unsuitable; revising the language and shifting perceptions of what is actually required makes the position accessible to her.

Second, the candidate must also play an "active" role in the maintenance of academic standards. Active implies up-front, visible, and dominating. We can imagine an articulate, forceful male putting forth his perspective at a meeting, but we may not be so quick to recognise the female (or indeed male) who performs the task in a less outspoken way. Language in a job description, such as *innovate*, *create ethical basis,* or *foster growth of* academic standards, would help to broaden perceptions of suitable candidates.

New Expectations of Male Roles

Many traditional male roles emphasise male qualities. The essential criteria are those skills and traits that men are likely to possess, while the desirable criteria are often more female traits. Adding in desirable female components to the job description would also help make the workplace accessible to women. The desirable criteria for a job may include "tactful negotiator", "supportive member", or "ability to empathise", but it is unlikely that these (more female) desirable qualities would make their way into the essential criteria in a world where there is already a well-defined perception of who should to be at the top.

We also note that there are some expectations accompanying traditional male positions—for example, that the role is undertaken full-time, the employee shows full commitment to it and demonstrates that it is a priority in his or her life and not secondary to other roles the person may play—whether in family or study or community. Unfortunately, women are more likely to be involved in these other roles and often unwilling to give them up to follow the male-dominated model where the one working or professional role is the most important thing in life. Some women may want to sacrifice family or community involvement in order to play male roles, but why should women be forced to do so before they are taken seriously? Why should the majority of part-time work available be in low-paid unskilled jobs, and why should women have to relinquish family or community in order to qualify for those worthy male jobs that must be full-time?

Naturally flexibility in terms of job-sharing, part-time work, particular duties undertaken, and so forth would have serious implications for employers (who for many reasons prefer full-time staff), but if the male-dominated worldview is to be challenged and changed, making positions truly accessible to all (and not imposing the traditional view) is necessary. It is a complicated issue, how the benefits of full-time salaried staff (e.g., in sick leave, superannuation, etc.) could be extended to employees who operate on a more casual basis (and naturally valuing the roles being played by each type of employee, would require similar benefits)—complicated, but this flexibility is surely part of the agenda; ambitious, but would ultimately make the workplace available to more than a few "determined" individuals. It is reasonable to expect that outside the male-dominated worldview, there are people who require and want greater flexibility and have just as much to offer the workforce, albeit on a part-time basis. They do not want to sacrifice their other roles to contribute to the workforce.

CONCLUSION

This article questions the equality that is pursued by the equal opportunity agenda. In many instances demanding women are given opportunity to take traditional male dominated positions in the workplace. This merely reinforces the male-dominated world, what it values, and what it requires. A worldview that rejects male domination at its core and acknowledges that there are many valid roles to play within the workforce—not just the stereotypical male role that receives the most credit—may benefit women more, rather than help them to chase after male-dominated creations. Thus this article questioned whether enabling women to play *exactly* the same roles as men is in fact the most beneficial way to address inequality. If equality has to be based on role at all, then let the roles be redefined and women allowed to play roles which are not *exactly* the same as male-defined roles, yet equally esteemed.

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KEY TERMS

Discrimination: The illegal treatment of a person or a group of persons based on a prohibited factor, including gender.

Equal Opportunity: The right of all persons to be accorded full and equal consideration on the basis of merit or other relevant, meaningful criteria.

Equality: The quality of being the same in quantity or measure or value or status.

Personhood: Person is normally equated with human although there are often certain disputes about whether certain humans are persons; in some instances divinity may be attributed personhood and the concept cannot so easily be equated with being human.

Role: The actions and activities assigned to, required, or expected of a person or group.

Workplace: The sector of society that receives financial remuneration for the activities undertaken, excluding most students, volunteers, homemakers, the retired, and pensioners.

P

The Pipeline and Beyond

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INTRODUCTION

Women have been involved with IT since the 19th century, when Ada the countess of Lovelace was the first programmer for Charles Babbage's analytical engine. Grace Murray Hopper's contributions to COBOL and computing several decades ago are considered so significant that an annual conference is held in her honor (see http://www.gracehopper.org). In fact, the earliest computer programmers tended to be women more often than men (Panteli, Stack, & Ramsay, 2001). As the IT field progressed, however, it evolved into what many still view as a male-dominated domain, some say due to its increasing association with power and money (Tapia, Kvasny, & Trauth, 2003). Today, women make up at least half of World Wide Web users (Newburger, 2001), but this has apparently not translated into a proportionate participation in IT careers.

IT managers must recruit and retain a skilled and diverse workforce in order to meet the needs of increasingly global enterprises where cross-cultural, heterogeneous work groups are the norm. However, numerous sources (Information Technology Association of America [ITAA], 2003; Zweben, 2005) agree that the proportion of females to males selecting and completing degrees in IT-related fields is declining. Not only are women missing out on career opportunities, but the IT profession is also missing potentially valuable alternative perspectives on system design (Woodfield, 2002).

Worldwide, the digital divide is more extreme for women than men (Hafkin & Taggart, 2001), with the result that in many developing countries, women's access to computers is more limited than men's access. However, IT is an important driver for economic development and should provide women with new opportunities to better their circumstances, provided that a variety of challenges, such as technical education and social and political norms, can be addressed (Hafkin & Taggart, 2001).

Even in more developed countries, females face well-documented (Margolis & Fisher, 2002; von Hellens, Nielsen, & Beekhuyzen, 2004) obstacles all along the pipeline beginning as early as middle school and continuing through college, graduate school, and the career. Developing solutions to recruit and retain women in IT may serve other underrepresented groups as well, making IT classrooms and IT workplaces more inviting and ultimately more productive environments for everyone.

BACKGROUND

Part of the challenge of recruiting and retaining women in IT stems from a lack of knowledge by the public in general about the changing nature of IT work. The original focus of IT in the 1950s was on writing code to create computer programs. Unfortunately, many today, including the media, still see programming as the primary IT job (Denning, 2004). Earlier investigations into women and computing suggested that IT work by its nature was a poor fit for females, seen as solitary and boring, a double-edged stereotype that apparently still exists today (American Association of University Women [AAUW], 2000a; Galt, 2002; Symonds, 2000). It is double edged because it perpetuates myths about IT, as well as about women, and so restricts their access to the field.

Another part of the challenge of recruiting and retaining women in IT is related to the definition of IT work, which is difficult to pin down (Gallivan, 2004). The field has evolved, and IT has become more integrated into most business organizations and into the work and home lives of many individuals, creating a wide variety of IT jobs. Today, IT work includes not only job titles such as programmer, systems analyst, system administrator, and software designer, but also software engineer, business analyst, database designer, database administrator, network analyst, network administrator, Web developer, Web engineer, human-interface designer, project manager, applications developer, security administrator, and help-desk technician.

Concurrent with the expansion of IT job titles and responsibilities, there has been an expansion of the venues in which IT is taught. For example, the computer-science (CS) curriculum focuses primarily on technical and related theoretical concepts with emphasis placed on software creation. The information-systems (IS) curriculum integrates technical skills and knowledge with applied business and organizational concepts. IS programs are sometimes found in business schools, other times in schools of science, engineering, or even stand-alone IT units. Variations include business information systems (BIS), computer information systems (CIS), and management information systems (MIS). The information-technology curriculum may focus on a specific subset of technology such as fourth-generation languages and maintenance. For the purposes of this article, IT is defined as an umbrella term that encompasses a variety of job categories that continue to evolve as hardware, software, and methods continue to increase in sophistication.

EARLY INFLUENCES

A growing body of educational research documents many factors that influence female attitudes, perceptions, and behaviors toward computers in K-12 (Ahuja, 2002; AAUW, 2000b; von Hellens et al., 2004; Young, 2000). In addition to general sociocultural trends that appear to dampen girls' enthusiasm and self-efficacy regarding math and sciences around middle school, girls seem to be influenced by the following:

- Low interest in computer games
- Teacher, parental, and peer attitudes
- Lack of access to and experience with computers
- Perceived usefulness, or lack thereof, of computers to themselves and to society
- Lack of IT role models and mentors
- Media images

These variables may be grouped into two main categories: environmental and individual. Environmental variables are those that make up the context within which career decisions are made, such as school or work, while individual variables are characteristics of individuals, such as aptitudes and preferences (Woszczynski, Myers, & Beise, 2003). Both interact to influence the choices and behaviors of individual girls and women (Trauth, 2002).

COLLEGE, GRADUATE SCHOOL, AND THE IT WORKPLACE

Some of these same factors apply as women move into college and graduate school. In a survey of Canadian college freshmen, both male and female students' perceptions of a career's prestige, required education, and starting salary were inversely related to their estimate of the percentage of women employed in it (Harris & Wilkinson, 2004). Often, due to less previous experience with computers and less preparatory coursework, women continue to experience ambivalence about their interest and abilities in IT, in spite of equal performance regarding computer skills. They often encounter hostile academic environments (Margolis & Fisher, 2002; McGrath-Cohoon, 2001), and their career choices are often influenced by work-family balance concerns.

Women are discouraged from the IT workplace in a number of ways. Women are often relegated to IT positions with less prestige, reduced rewards, and lower expectations of technical capability. Earlier studies reported that women are employed at lower levels, make less money, and are more likely to leave their organization than men (Baroudi & Igbaria, 1994-1995; Igbaria, Parasuraman, & Greenhaus, 1997),

Women are often channeled into "softer" positions that are coincidentally lower in status, generate reduced compensation, and lead to less visibility (Panteli et al., 2001). Female IT workers were found to be disproportionately assigned to end-user support or help desks, positions less favored by male employees. Also, females preferred project-management tasks while males preferred network design and maintenance work (Martinsons & Cheung, 2001). In a large survey of the IT workplace, Dattero and Galup (2004) reported that women are more often assigned to legacy systems using COBOL skills than they are to engineering new software using Java. In general, they report that women are assigned to tasks that are considered less challenging. Managers in one large company viewed women as having less technical expertise (Gallivan, 2004).

Critics have rationalized such findings by stating that the differences are due more to variances in age, experience, and education than to gender. When studies have controlled for these potentially confounding variables, the results are mixed (Baroudi & Igbaria, 1994-1995; Igbaria et al., 1997). However, more current research is needed to update these studies, which do not reflect recent industry changes, such as the dot-com boom and bust at the end of the 1990s.

Academic institutions and business organizations alike are realizing that they need to focus on retaining as well as recruiting women in school and in the workplace (Tapia et al., 2003). As with recruitment, both environmental and individual variables will interact to determine retention outcomes for women.

INTERVENTIONS AND SOLUTIONS

A growing body of literature provides a range of useful approaches to facing these challenges (Margolis & Fisher, 2002; Wardle & Burton, 2002). One way of addressing the problem is to focus on individual factors, that is, to change the individuals by changing attitudes, dispelling stereotypes, improving preparation, and increasing experience with computers. Suggestions aimed at K-12 levels and beyond include the following.

- Providing more (and more equal) access to computing resources.
- Designing girl-friendly games and applications to encourage more experience with computers, which leads to higher self-efficacy.
- Creating videotapes and other positive media images that demonstrate women in professional IT roles, thus changing attitudes.
- Encouraging girls to take more courses that adequately prepare them for IT-related college majors.

Taken to an extreme, this approach implies that in order to succeed in this male-dominated field, women must become more like men. An alternative perspective, then, is to change the environment by making it less hostile, less masculine, more family-friendly, and more accepting of diversity. Interventions that have been suggested and implemented (AAUW, 2000b; Ingram & Parker, 2002; Werner, Hanks, McDowell, Bullock, & Fernald, 2005) to address environmental factors, at multiple academic levels, include the following.

- Train teachers to provide more equal access and to reduce the stereotyping of computing as a male domain.
- Provide students with female mentors and role models, including female faculty members and mentors from industry.
- Create communities, study groups, clubs, and other social supports for female students.
- Broaden the range of computing activities for younger students.

- Develop programs that do not depend on a substantial mathematical and scientific background prior to beginning college. Provide bridge opportunities to increase experience, build competency, and improve self-efficacy
- Consider the use of pair programming and other learning strategies in IT courses to provide opportunities for more teamwork

Business organizations have also implemented programs that target many of the individual and environmental factors listed above (Bentsen, 2000; Ingram & Parker, 2002; McCracken, 2000; Taggart & O'Gara, 2000). Suggested initiatives include the following.

- IT training (intraorganizational and community outreach)
- Mentoring programs, support networks, and general diversity training
- Visible top-management support and an external advisory council to promote cultural change
- Promotion of work-life-family balance values and programs for women and men, such as continuing education, flextime, day and elder care, and concierge services (often viewed by women in particular as more important than on-site game tables and sports outings)
- Examination of explicit and implicit reward systems, which may evaluate men differently than women, and which may not reward teamwork and communication as valuable leadership skills as much as more traditional definitions of achievement
- Staffing project teams for more gender balance to promote productive communication styles

FUTURE TRENDS

When IT workers are compared to other categories of workers, two interesting findings emerge. First, persons with a formal education in IT are less likely to pursue work outside of IT than are persons with formal education in other areas. Second, the IT workforce contains a large number of people without formal IT credentials or even traditional undergraduate education (Wardle & Burton, 2002). This situation has likely arisen because IT is a relatively new field, because it has grown rapidly, and because there is a growing need to apply IT to other functional areas from which these employees come.

One frequently cited source of enrollments in computer-science programs (Zweben, 2005) focuses solely on research institutions (defined as those that offer a PhD in computer science). PhD-granting programs clearly play an important role in the pipeline by providing female IT academics to serve as role models for women enrolled in college. However, a recent study in Georgia (Randall, Price, & Reichgelt, 2003) suggests (a) that more women (all majors) attend non-PhD-granting state universities and colleges than research institutions, (b) that CS, IS, and IT degree programs at these state universities and colleges attract a higher percentage of women than do the research institutions, and (c) that IS and IT programs attract more women than CS programs. The applied nature of IS and IT programs is likely to be part of the reason why these programs are more attractive than CS programs, given women's apparent preferences for work that involves social interaction and social benefit (AAUW, 2000a).

The picture of why women leave the IT field, or choose not to get into it in the first place, is still incomplete and fragmented. Further research is needed, particularly in workplace settings, in order to better understand the problem and apply effective solutions. Furthermore, although a number of interventions have been suggested and even implemented, little is known about their effectiveness over time. Researchers need to engage in longitudinal studies in order to further enrich the body of knowledge.

CONCLUSION

Interventions for recruiting and retaining women in the IT workforce need to address self-confidence regarding computing; the related lack of experience, precollege preparation, mentors and role models, and community and study groups; and the importance of valuing both family and work priorities. More systemic solutions would transform the masculinized IT academic departments and workplaces into friendlier, more supportive environments for all workers. A summary of recommendations for IT practitioners, IT educators, and IT researchers toward addressing both individual and environmental factors includes the following.

1. **Advisors to Young Women:** Educate the public. Share knowledge about the evolving nature of IT work, particularly with parents, counselors, teenagers, and other influential groups. Narrow stereotypes need to be replaced by the realities of an exciting and socially fulfilling IT career.
2. **IT Educators:** Educators should get involved in all levels of education to identify, attract, support, and develop well-qualified women for IT positions. Broaden the definition of IT to include not just CS, but also IS and related majors, and contribute to continued curriculum development that balances important theoretical foundations with applied, practical application. Such curricula are more likely to appeal to women, who tend to view computers more as useful tools than fun toys.
3. **IT Practitioners and Educators:** The business climate should be examined to identify ways to make IT more attractive to women. Rather than on-site games and sports outings, many women find more appealing practical programs that support time management and work-family concerns (Bentsen, 2000). Such programs are likely to increasingly appeal to men as well, as youthful IT workers age, marry, and have children.
4. **IT Practitioners:** Initiatives that have been successful in IT education should inform managers seeking qualified women for IT positions. These initiatives include the development of mentoring programs, support networks, and general training on respect for diversity and multiculturalism for all workers.

Finally, many organizations are beginning to appreciate the value of a newer, more facilitative leadership style that is often associated with women, which includes teamwork, participatory decision making, and interpersonal communication skills. If such behavior is recognized and rewarded, this could help attract and promote more women into the managerial ranks of IT, eventually transforming the IT workplace and perhaps leading to broader perspectives in software and interface design.

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KEY TERMS

COBOL: COmmon Business Oriented Language; a programming language used for business applications on mainframe and minicomputers.

Computer Science (CS): A more traditional IT curriculum whose focus is technical and theoretical rather than applied, with emphasis on software creation.

Environmental Variables: The context within which career decisions are made, such as the school and work environments.

ERP: enterprise resource planning; an integrated information system to serve all departments of an organization.

Fourth-Generation Language: Business application languages and tools such as database- and decision-support tools like SQL, ACCESS, and EXCEL; ERP and other reporting tools; and Web development environments such as Cold Fusion and Frontpage.

Individual Variables: Characteristics of individuals, such as attitudes and preferences.

Information Systems (IS): A curriculum that integrates technical skills and knowledge with applied business and organizational knowledge. It is sometimes found in business schools, and other times in schools of science or engineering, or in stand-alone IT academic units. Variations include business information systems, computer information systems, and management information systems.

Information Technology (IT): (a) An umbrella term that encompasses a range of professional positions requiring at least a baccalaureate degree in computer science, information systems, or closely related majors. (b) A major that focuses mainly on fourth-generation language application development and maintenance.

SQL: Structured Query Language; used to query and process data in relational databases.

Postcolonial ICT Challenges

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INTRODUCTION

This article has a particular interest in the introduction of ICT in the postcolonial parts of the world. The fundamental arguments for investing in ICT all over the world rest on the view of ICT as a necessity for successful integration into the world economy. ICTs are regarded as having great potential to promote development in key social and economic areas where a shortage of capital, knowledge and local capacity obstructs progress. However, "information itself does not feed, clothe or house the world" (Main, 2001, p. 96), and it remains to be seen whether ICTs in developing countries will create wealth among the poor in those countries or among the already wealthy.

In the promotion of ICTs for development, the introduction of these technologies is mainly discussed in technical terms, considering the problems of electricity, telephone access, and expensive computers. The argument for introduction is also rather instrumental, expecting income generation and economic improvement. At the same time, ICTs are sometimes referred to as revolutionary, but they will travel on existing technologies, modes of communication and (post) colonial relationships.

The introduction of new technologies will not only be regarded as a technical issue. It may also be politically sensitive, if the technology shows signs of disrespect for the local culture, if it promotes only specific groups and ways of life in the local society, or if it bypasses the local society when reaching out for a specific target like a company (see e.g., Redfield, 2002). As for example Weckert and Adeney (1997) argue, the spread of ICTs in diverse cultural settings might very well be regarded as cultural imperialism, given the unequal access to resources for alternative technologies or content. The directions that ICTs lead towards, for example distant communication, may be interpreted as unifying and networking on a global scale between interest groups to their own and society's benefit. ICTs may also lead to an increased spread of (androcentric) American and western ideals and commercial products, increasing the global dominance of the U.S. and other western nations. These examples show the impossibility in treating technologies as neutral tools.

The aim of this article is to develop postcolonial and feminist technoscience requests for context sensitive and distributed ICT processes in relation to the development of ICTs for Tanzania at the University of Dar es Salaam.

BACKGROUND

The position of "having never as much" (Redfield, 2002, p. 810) will for a long time be the position from which people in the Third World will receive ICTs. In his study, Redfield showed what reactions and tensions this position may create. Are ICTs yet another way of imposing control, of deciding what is important to know and to have, of showing who is in charge of globalisation? Are they yet another demand on transfer from national to private and commercialisation of common goods? A tool "to make the poor dream the same dreams as the rich" (Martín-Barbero, 1993, p. 165)?

Mörtberg (2000) raises the issue of equal access to ICT in a time when we see less of arguments for "technology in a democratic society" and more of arguments for "democracy in an information society". Equal access, referring to gender, class, race, religion, language etc. is by no means inherent in the ICTs. The gender dimension in the case of ICT in the postcolonial context relates to a double burden of men's supposed supremacy in technological matters, and women's specific barriers in the developing world, including illiteracy, unfamiliarity with English (that dominates the Internet), domestic work load, lack of valuable information on the Internet, and lack of connectivity in rural areas where women primarily live (Gurumurthy, 2004).

The links between equal-level[1] participation and ICT development or ICT policy development are created by means of hard work and tedious dialogues, multidimensional partnership co-evolution with developed and working sensitivity and awareness of diverse interests, gender dimensions and cultural—ethnic pluralism, among other components in an increasingly complex world.

Suchman (2002) argues that the *design from nowhere* is a result of the idea that technical systems could be constructed with a minimal cultural connection "as commodities that can be stablized and cut loose from the sites of their production long enough to be exported en masse to the sites of their use" (p. 140). Suchman also points out that the distinction between designer and user is not straight forward. The designers are users of their own products, and that invisible design-in-use often takes place without rigorous documentation. "Even to keep things going on 'in the same way' in practice requires continuous, mundane forms of active appropriation and adaptation of available resources" (p. 143).

Requests for access to communication (not only information; Colby, 2001), relevant material (e.g., Morley & Robins, 1995) and appropriate modes of communication practices (oral/literal, face-to-face or over distance; Mejias, 2001) highlights the borderline between ICTs supporting imperialism or pluralism. "Our challenge lies in theorizing exactly this interstitial space between agency and the lack thereof, between being constructed within structures of domination and finding spaces of exerting agency" (Shome & Hegde, 2002, p. 266).

These issues make it necessary to investigate and de-naturalise the discussion of former colonies as nations in need of ICT *transfer*. As Rwandan ICT expert Albert Nsengiyumva has stated[2], all electronic technologies have been brought into the African countries from outside. The new ICTs are often referred to as a sign of the jump from the modern into a postmodern age. Hess (1995) is very critical of the reference to a global postmodern age,

before claiming that "we" are living in a postmodern age, it is worth remembering that not everyone is included in that we. *Cyberspace is an elite space ... There* is *a glass ceiling, and for many in the world a large part of postmodern technoculture lies well above it.* (p. 116)

THE ROLE OF THE UNIVERSITY IN TANZANIAN ICT DEVELOPMENT

Feminist technoscience with emphasis on ICT is certainly motivated by transformation goals. The needs for transformation are not only seen in the ongoing difficulties of achieving appropriate ICT system solutions especially in low income countries, but also in a more general process of knowledge and technology development (Gibbons et al., 1994; Nowotny, Scott, & Gibbons, 2001). The latter urge for transformation not the least within academy and technical faculties (Etzkowitz & Leydesdorff, 1997). Feminist technoscience within technical faculties is a driving force for the transformation processes required (Trojer, 2002). The transformation on a deeper level is vital to address appropriateness, access and utilisation not only for women within the academia, but for the majority of women in the local society (Gurumurthy, 2004).

In order to be able to understand and learn about distributed knowledge and technology production you have to be situated in a very concrete, day to day practice as well as achieve broad contextual knowledges. The postcolonial situation carries the potential for distributed knowledge production that are of particular interest in this sense. Experiences from Tanzania and the role of the main university of the country will be used to elaborate on these negotiation processes.

Relevance and Transformation

The University of Dar es Salaam (UDSM) is the main university out of five in the country and the only university holding a technical faculty. The challenge for the university as an actor in societal development is huge. High expectations are placed on the implementation of ICT, which can be recognised in strategic documents of UDSM:

As part of the ongoing transformation programme, the UDSM has initiated a number of reforms aimed at improving its main outputs (teaching, research and services to the society) through ICT. The improvement of ICT aims to suit the needs of the students and staff, the working environment and establish linkages with both industry and government. The new ICT developments are also expected to contribute to income generation in order to complement government and other funding sources to ensure sustainable academic programmes. (University of Dar es Salaam, n.d., para. 1)

The vice chancellor emphasizes that within the larger transformation activities of the university the issue of *relevance* becomes central. As far as possible a public university in a very poor country must aim to be relevant to the developmental aspiration of the people in all knowledge areas.

The transformation should go deeper in the academic organisation culture, the vice chancellor argues.

I must say it is not easy. If you want to bend a fish you bend it while it is still alive, before it is dry. If dry you crack it. We have come to learn that it is a bit difficult. We are still struggling with it. (vice chancellor, interview September 12, 2003)

Resource for Society and Government

The experience of approving ICT at the university started in 1993. Responsible people at UDSM put in a 2 MBite wireless line to the university main campus. UDSM even brought Internet to the Tanzania telephone company (TTCL) and not the other way around. Now, twelve years later, Tanzania has Internet backbone in every region. In order to reduce the costs and ensure connection for the ministries, the university also connected eight government ministries to the wireless internet line at UDSM. As a result of this process, expert people from UDSM are now managers at TTCL.

Today, when the university competes with several other Internet service providers (ISP), a number of governmental bodies are still connected through the university link. The impact of the initiative coming from the university was an increased motivation for the university staff to keep on with ICT development, as the university staff members were the only ICT experts within Tanzania at that time. For the content development for the government (eGov) the process is both ways. The governement as well as the university are looking to find the easiest way to implement the governement's own processes and demands, which are monitoring, evaluation and easy communication. UDSM is trying to provide that kind of solutions.

ICT Politics and Borders in Question

The University of Dar es Salaam (UDSM) played a key role in the national ICT policy process. The policy draft was developed in a very broad and open process to reduce the dominance of the academy. The role of UDSM in the policy process can be viewed as part of a sensitive technopolitical agreement between the university and the governement. We have to keep in mind that the knowledge experts of ICT in Tanzania were and are mostly located at UDSM or trained at the same place as the only institution having a technical faculty in the country.

The national ICT policy gives a substantial understanding of the status of ICT in Tanzania as well as strategic areas for ICT and development. One of the central statements concerns the needs for Tanzania to move from being mere consumers of technology to being the designers and manufacturers of ICT.

At UDSM, the issue of how to achieve the dreams like poverty reduction, more education, gender equality and so forth is on the agenda. ICT can provide tools for this, but how much is really Tanzanian? The academic staff regards ICT as more promising than other technological fields in this sense:

We have a kind of technology where we can provide significant content of products, more than 60% as equal partners in the provision of products and services. This is mainly knowledge based. We have an opportunity to do that (provision) much more than in for example nuclear physics. (interview with academic staff, September 2003)

A department director at Tanzania Commission for Science and Technology (COSTECH) stressed that,

it is very unfortunate that computers came to Africa as prestigious tools, as elite, sophisticated tools and not as non rocket signs. This is a myth that came with them. Computers are just ordinary technology, much easier than automobile and more powerful than automobiles, because they are all knowledge based. Knowledge based technologies transform individuals. Many have a lot of interest in them. The West pushed computers as tools for private sector. That this is not true was not understood by the governement ... It all depends on how you look at things within your own country ... This element of articulation is what we need to do.

FUTURE TRENDS

Experiences from international feminist research closely linked to dominant areas of technology (information technology, biotechnology, and material engineering) imply recognition of techno- and research politics deeply rooted in understandings of knowledge and technology production as processes which occur in distributed systems. In other words, knowledge creation today takes place on the boundaries between universities, private sector, public sector and the political spheres.

We can recognize ICT as one of the technological science fields most evidently challenging the borders between academic research and politics/society (Gulbrandsen, 2000) and experience how the negotiations (Aas, 2000) about the character of academic research take place in society. Academic ICT and its applications in society and every day life force our attention towards the relation between dominating actors, of which the university is one. It stresses relevant knowledge about its prerequisites, which in turn results in transformation challenges within the traditional universities. One model explored for these processes has been the *triple helix model* stating that the three institutional bodies university, industry and governement are increasingly working together (Uhlin & Johansen, 2001). The triple helix model focuses more on the outer frame for the processes. The actual knowledge and development processes are more explicitly discussed within the concept sphere of *mode 2* (Nowotny, Scott, & Gibbons, 2001). Mode 2 knowledge is created in a broad and transdisciplinary social and economic context involving varying actors and participants in the research process. This is seen in contrast with the traditional scientific knowledge, produced in separate, academic institutions with efforts to *reduce* influence from the society.

In a developing country like Tanzania in particular, the process of mode 2 knowledge production in a triple helix formation will present an example for the traditional academic institutions in the industrialised parts of the world. We see that the ICT development in Tanzania and other postcolonial countries will have an advantage in this sense of intensive interaction between different actors in society.

However, as already stated, equal access for people in rural areas, women in particular, and disadvantaged groups, will require active participation also from local organisations and NGOs with feminist agendas (see Gurumurthy, 2004, p. 42ff).

CONCLUSION

From our perspective, the situation at UDSM carries potentials of a contextual awareness that opens for a benign triple helix knowledge and technology production. A more broadly defined group of stakeholders in the early phases of ICT development may increase the robustness of the choices that are made along the road.

At UDSM in Tanzania, the priority of collaboration with institutions outside the university shows a potential for an ICT development drawing from a more conscious technopolitical work in a postcolonial situation. The recognition of the necessary efforts to enter into technology *development* has a potential to bring about a more domestic and context aware ICT development process. Feminist technoscience perspectives are supporting these processes.

If the ICT priorities of African nations shall become directed towards the population, internal expertise needs to develop the technologies and to utilise them. As the quotation from the department director at COSTECH indicates, the way ICT was introduced by foreign companies and nations can be criticised for attempting to retain an unnecessary control, carrying colonial marks, over the use of technology in the postcolonial context. The people at UDSM and COSTECH, however, have made conscious efforts to change the situation of "having never as much" into a situation where the control over the ICTs lies with the domestic expertise. As the interviewed academic staff member acknowledged, this is easier to achieve with ICT, which is knowledge based, than in other technological fields which are more technology based.

The issues of software and content have not been addressed as thoroughly as the technical infrastructure. What we here regard as knowledge production within a triple helix or mode 2 system involves the technical expertise at the Tanzanian universities and in the Tanzanian society. Continuous efforts to address equality issues and access to ICT for diverse user groups, including women and men, rural and urban and so forth are needed.

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KEY TERMS

Cyberspace: A world-wide computer network that allows people to communicate with each other.

eGov: The governement's information and communication with citizens via the use of the Internet.

Internet Backbone: A larger transmission line that carries data gathered from smaller lines that interconnect with it. On the Internet or other wide area network, a backbone is a set of paths that local or regional networks connect to for long-distance interconnection. The connection points are known as network *nodes* or telecommunication data switching exchanges (DSEs).

Mode 2 Knowledge Production: Some characteristics of mode 2 knowledge productions are situated in the context of application; distributed knowledge processes; development of robust knowledge; subject to multiple accountabilities.

Postcolonial: The period after the independence for colonized states in Africa, Latin America and Asia. Postcolonial also refers to a discursive space that has opened up for diverse positionings, discussions and practices after independence.

Technoscience: In the new fields of ICT, biotechnology and material sciences in particular, science and technology are so intimately related that they have merged into one. The concept of technoscience signals that the boundaries between science, technology, politics and society are about to weaken.

Triple Helix: Knowledge production taking place in the collaboration between the university, the government and the industry.

Wireless Technology: Wireless is a term used to describe telecommunications in which electromagnetic waves (rather than some form of wire) carry the signal over part or the entire communication path. Wireless technology is rapidly evolving, and is playing an increasing role in the lives of people throughout the world. In addition, ever-larger numbers of people are relying on the technology directly or indirectly.

ENDNOTES

1. The authors have borrowed Jan Åhlander's concept of the equal-level perspective in order to overcome the dichotomy of the top-down / bottom-up perspective (lecture notes, Jämshög folk high school, 1991).
2. Workshop held at Blekinge Institute of Technology October 23, 2003.

Postmodern Feminism

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INTRODUCTION

Since the 1970s, researchers have been using gender as an analytic category to study information technology (IT). In the decades since then, several questions have been raised on an ongoing basis, such as: How is gender constituted and reproduced in electronic spaces? Can the Internet be a place where there is no gender, a place where gender becomes fluid and malleable? How are identity and the politics of identity constructed online? Some scholars studying these questions have relied on feminist standpoint theory to frame and inform their inquiries into these issues, which foregrounds the differences between men's and women's experiences in electronic spaces and computing in general. However, others, particularly throughout the 1990s, have found postmodern feminist theory to be not only more accurate for explaining the actual practices of electronic communication and behavior, but also more conducive to the achievement of feminist political goals. The sections that follow will explain the general principles of postmodern feminist theory and its use in studies of gender and computer-mediated communication.

BACKGROUND

What is known as postmodern feminism is often associated with the work of Judith Butler (1990, 1993) and is marked, in part, by a "linguistic turn," a view of gender as a discursive construction and performance rather than a biological fact. These theorists criticize the conflation of sex and gender, essentialist generalizations about men and women, and the tendency to view gender as fixed, binary, and determined at birth, rather than a fluid, mobile construct that allows for multiple gender expressions. The gender dichotomy of man/woman so pervasive in Western culture can be understood in terms of the cultural imperative to be heterosexual and a history of biological determinism in Western philosophy. Postmodern feminism rejects a dualistic view of gender, heteronormativity, and biological determinism, pointing to the inseparability of the body from language and social norms. Medical professionals can, for example, conform to and reinforce social norms by surgically transforming an infant with ambiguous genitalia into a culturally intelligible girl proper whose clitoris is a socially acceptable size (Butler, 1990). Medical technological intervention is also responsible for sexual reassignment surgery, making the materiality of gender malleable and blurring the boundaries between "man" and "woman." Postmodern feminists argue against the assumption that all women share a common oppression; this assumption has, unwittingly totalized and naturalized the category of "woman" into a white, heterosexual, middle-class, able-bodied, young- to middle-aged norm. Moreover, avowing political categories such as "woman" or "queer" as part of one's identity, what is called "identity politics" is both intellectually and politically misguided. Identitarian terms, such as "transgender," according to the postmodern school of thought, emerge into discourse at certain points in history, and it is important to keep this point in the foreground. Ignoring a term's history can end up reifying the term and reinforcing its place in a discursive hierarchy.

From this body of work, the theorist whose work has been particularly influential to scholars of gender and IT is Donna Haraway. Haraway (1985) argues that in a culture of high technology, the boundaries are no longer clear between human and animal, animal and machine, or human and machine. While not a new observation, Haraway recasts it as a windfall for feminist theory; hierarchical dualisms such as man/woman, heterosexual/homosexual, and white/black are no longer stable in high-tech culture. High technology is embedded so deeply in politics and knowledge (examples include artificial intelligence, genetic modification of organisms, and reproductive technologies) that the technologies are no longer tools deployed by agents in positions of power but now, to a great extent, they construct those agents. New technologies prompt redefinition of such concepts as literacy, work, nature, reproduction, and culture. Haraway argues that taking the cyborg, a figure without boundaries that is both human and machine, as a metaphor for socialist feminist theoretical interventions can be useful for feminist theory because it can help feminist theorists imagine a world that is not seen in or confined to hierarchical dualisms. The cyborg resists and eludes final definitions, as should feminist theory to avoid totalizing the category of "woman."

Braidotti (2003) suggests three potential ways to use the cyborg metaphor as an intellectual tool. First, the cyborg as an analytical tool "assists in framing and organizing a politically invested cartography of present-day social and cognitive relations" (p. 209). Second, the cyborg functions in a normative mode to offer a more complex and nuanced evaluation of social practices (see Selfe & Selfe, 1996). Third, we can use it as a "utopian manifesto" for imagining ways to "[reconstruct] subjectivity in the age of advanced technology" (p. 209). Also, with its focus on the organic and technological body, the cyborg metaphor keeps the body in view; one charge against postmodern feminism is that the materiality of the body "on the ground" gets lost in theorists' preoccupation with discourse.

POSTMODERN THEORY AND IDENTITY IN CYBERSPACE

When the World Wide Web became popular and commonly used, some wondered if the Web could become a truly democratic place, where discrimination on the basis of race, class, or gender could be eliminated. As much research has shown, however, and indeed as anyone who happens upon racist and misogynistic Web sites can attest to, the Web is not a utopia. Feminists have responded to gender inequalities online in several fashions, but Hall's (1996) study of women's experiences online makes a useful distinction between what she calls "liberal cyberfeminism" and "radical cyberfeminism" in online discussion practices (see also Wolmark, 2003). What Hall terms liberal cyberfeminism is "influenced by postmodern discussions on gender fluidity by feminist and queer theorists, imagines the computer as a liberating utopia that does not recognize the social dichotomies of male/female and heterosexual/homosexual" (p. 148). Radical cyberfeminists, on the other hand, are concerned with everyday online problems: homophobia, harassment of women and pornographic representations of women, and they seek to create safe spaces for women only (see Herring, 1996).

Liberal cyberfeminism corresponds with a postmodern feminist view of gender as mobile and performative, not necessarily tied closely to identity. In online spaces, identity is constructed in communities with certain discursive norms, and identity is based on conversations and credibility established in those conversations; as such, only the community decides whether they accept the user as a woman, a disabled person or the like. Turkle (1995) and Stone (1995) use postmodern theories that problematize the humanist subject to show that online heightens the sense that identity is shifting, fluid, de-centered, and multiple; online, identity is a series of fictions and textual play—"personae all the way down" (Stone, 1995, p. 81). Turkle (1995) claims that computing is taking us "from a modernist culture of calculation toward a postmodernist culture of simulation," from "centralized structures and programmed rules" to "a postmodern aesthetic of complexity and decentering" (p. 20). Turkle (1995) agrees with Haraway that "the computer is an evocative object that causes old boundaries to be renegotiated" (p. 22). One such boundary is that between "man" and "woman."

Turkle (1995) cites netsex as one such simulation that allows for the flexibility of identitarian categories, with what she suggests is rampant "virtual gender-swapping" (p. 212; see also Bruckman, 1993). Turkle describes several cases of gender swapping and finds that "a virtual gender swap gave people greater emotional range in the real" (p. 222). Not only does this kind of gender play give users a space in which to express masculine and feminine aspects of their personalities, virtual gender-swapping also lets users explore their sexuality. For example, women can play men to have netsex with other women, and men can play women to have netsex with other men. Heterosexual women can play lesbian and bisexual women, and heterosexual men can play gay and bisexual men (Turkle, 1995). Gender-swapping in online spaces disrupts traditional gender hierarchies, which is desirable for postmodern feminism. Butler (1990) argues that subverting gender norms through parodizing traditional gender roles, cultural unintelligibility (e.g. rejecting gender as do gender queers), and gender proliferation is good for feminism: "The loss of gender norms would have the effect of proliferating gender configurations, destabilizing substantive identity and depriving the naturalizing narratives of compulsory heterosexuality of their central protagonists: 'man' and 'woman' " (p. 187). Hall (1996) claims that a postmodern feminist approach is "identified by an insistence on equality rather than oppression" (p. 151; see also Plant, 1996). Playing with gender or abandoning it altogether allows women and men to reject traditional roles and avoid occupying assigned positions in the hierarchical dualism of man/woman.

FUTURE TRENDS

Much of the work that draws upon postmodern feminism has used multi-user domains (MUDs) and MUD object-oriented (MOOs) as its objects of study. With their encouragement of role-playing, gaming, and other forms of creativity, including imaginative work such as writing detailed descriptions of objects, rooms, sensations, and people, MOOs and MUDs provide ample opportunity for spontaneity and experimentation. However, the technology is changing; people do not use MUDs and MOOs much anymore. Instead, asynchronous publication tools, such as weblogs, wikis, and audio software for podcasts are becoming more popular. While gender-swapping is not entirely absent on weblogs (Sorgatz, 2004), it is less common, and the studies of gender and communicative practices using these new tools reflect this. As a result, many researchers in computer-mediated communication interpret gender online on the practical basis of self-identification and gender cues. Comstock (2001), in her study of grrrl zines, approaches gender from a third wave feminist perspective, carefully pointing out that she is not using the term "women" (or grrrls) to mean one group with common attributes, which often is hegemonic, taking white middle-class women's agendas and experiences to be the norm. Rather than stating her theoretical assumptions about gender, she only writes that she is not using the term "women" to mean one set of attributes, and she seems to rely on self-identification only as a gender indicator. Comstock discusses grrrl zine authorship, which is highly political and helps young women to participate in a public sphere. Discourse on grrrl zines "is often articulated at the site of the traumatized, adolescent female body" and embodied in narratives of abuse and body image (2001, p. 388). Comstock's research relies in a tacit manner on postmodern feminist theory, with a focus on gender as discursively produced.

In their study of gender and weblogs, Herring, Kouper, Scheidt, and Wright (2004) clearly explain how they classified bloggers as men or women:

> *Gender of blog authors was determined by names, graphical representations (if present), and the content of the blog entries (e.g., reference to "my husband" resulted in a "female" gender classification, assuming other indicators were consistent). Age of blog authors was determined by information explicitly provided by the authors (e.g., in profiles) or inferred from the content of the blog entries (e.g., reference to attending high school resulted in a "teen" age classification). The gender of the blog author was evident in 94%, and the age of the author in 90%, of the blogs in the combined samples.* (online)

Herring et al. acknowledge heterosexual gender norms and how bloggers present a particular gender online, and while they do not discuss specific feminist theories that inform their interpretation, one can see that they interpret gender based on self-identification but also on discursive performance, which speaks to Butler's (1990, 1993) theories of gender as performance.

What weblogs, podcasts, and zines have in common is a desire to reach an audience. Whereas with synchronous conversation, in which role-playing is common, it might be easy to try on various identities, new publication technologies encourage the maintenance of a stable Web presence, the garnering of a readership, the interaction with a public. It is more difficult to inhabit another gender category for an evening than it was before, and it is also more difficult to use theories that argue for shifting and multiple gender identities to study online activity when the actual practices are so divergent from the theories' claims. Also, postmodern feminist theorists who study science and technology, such as Plant (1996) and Haraway (1985), have been criticized for an overly utopian view of technology. Because the emphasis has shifted from MOO and MUD activity to citizen media, future feminist work with computer-mediated communication will make more use of feminist theories that deal with notions of public, private, and personal narrative, including Fraser (1992) and Benhabib (1992).

CONCLUSION

There is now a large body of research and theory of gender and IT. Gender and IT is a field with a history, but more research remains to be done, and lingering questions and problems exist. One such problem is postmodern feminism's concern with the continued assumption (and potential reification) of a man/woman, masculine/feminine gender binary (LeCourt, 1999). LeCourt (1999) observes that much feminist research in computer-mediated communication relies on essentialist or constructivist models of gender, both of which reify a masculine/feminine, man/woman gender binary. However, while it might be theoretically sophisticated to approach IT from the perspective of postmodern feminism, in the everyday practices of IT—education, work, and communication—most people do identify themselves as either men or women, however problematic those identitarian processes may be. Moreover, much astute policy research has been done on behalf of women in IT, research that assumes a male/female dichotomy. Recovery work on the history of technology, especially that of Sadie Plant (1997) and Cheris Kramarae (1988), reveals that women have always been part of the production and use of machines. The underrepresentation of women in IT careers and education is still a problem, and while the research done so far on women's experiences in IT education and the IT workplace has been helpful, more needs to be done to assess the industries' and educational institutions' efforts to create a more egalitarian workplace.

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KEY TERMS

Essentialism: The belief that all members of a group share common attributes. For gender, men might be seen as naturally strong, aggressive, logical, and independent, women as naturally weak, passive, emotional, and dependent on social relationships.

Grrrl Zines: Not-for-profit publications (print or online) containing art, creative writing, political rants, essays, collages, or anything else the author can imagine. Often associated with punk rock and the Riot Grrrl movement, a feminist movement situated in the early 1990s in Olympia, Washington and Washington, DC.

MOO: An abbreviation for MUD, Object Oriented. Unlike a basic synchronous chat space, a MOO contains rooms and objects. Both MOOs and MUDs are text-based, meaning that paragraphs of description serve in the stead of images of objects.

MUD: An abbreviation for Multi-User Dungeon, Multi-User Domain, or Multi-User Dimension. MUDs are spaces where multiple users are logged in at the same time, often to participate in role-playing games.

Netsex: Also called cybersex, netsex refers to the act of participating in a role-playing sexual situation. Netsex usually takes place in synchronous chat venues. Turkle (1995) also uses the term "TinySex" to denote netsex that takes place in TinyMOOs.

Performativity: A term associated with poststructuralist feminism. The idea that gender is a learned, daily act grounded in social norms of heterosexuality, femininity, and masculinity rather than biological sex.

Weblog: Also called "blog." A frequently updated Web site consisting of timestamped posts in reverse chronological order.

Wiki: A Web site that runs on software that enables any reader to add or edit content on the site. As a result of this affordance, wikis are highly collaborative.

P

Predicting Women's Interest and Choice of an IT Career

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INTRODUCTION

Research has supported the need to develop separate models for predicting men's and women's career interests. Women's career interests, particularly in nontraditional fields in science, engineering, and technology (SET), are considerably more difficult to predict than are men's (O'Brien & Fassinger, 1993). A number of factors have a significant impact on women's career interests and choices but have little effect in predicting men's career interests (O'Brien, Friedman, Tipton, & Linn, 2000). One of the most striking gender differences is that there is a much weaker connection for women than for men between interests, enjoyment, and career choice (O'Brien & Fassinger). The failure to make this connection is one explanation for the troubling finding that the majority of young women express interest in sex-typical careers that do not match their skills and are far below their ability (O'Brien & Fassinger).

Gender differences in the factors that predict career interest apply to the field of information technology as well. There are significant gender differences in all aspects of the IT pipeline, from how women become interested in the computing field to how they enter and remain in it, as documented by Almstrum (2003).

BACKGROUND

Understanding women's interest in IT careers cannot be reduced to a single factor or to a cluster of factors. It requires the consideration of a broad palette of environmental, social, and personal characteristics that generally are beyond the means of a single instrument to capture. Parental characteristics and support are environmental factors often recognized as central to women's career orientation and choice. Attitudes about technology and computer use are two additional factors that are frequently linked to interest in IT in the research literature. These factors are reviewed briefly in the following section.

Parental support. A fairly substantial body of empirical research documents the instrumental role of parents in the career orientation and choices of high-school and college women (Altman, 1997; Fisher & Griggs, 1994; Ketterson & Blustein, 1997). Parents have a greater impact on career choice than do counselors, teachers, friends, other relatives, and people working in the field (Kotrlik & Harrison, 1989).

An instrumental role played by parents in career decision making is in their support of career exploration. Parental attachment is positively associated with vocational exploration among college women

(Ketterson & Blustein, 1997). Parents who discuss issues openly and promote independent thinking in their children encourage more active career exploration (Ketterson & Blustein). Mothers, fathers, and siblings play a positive role in promoting career exploration by indirect means such as providing emotional esteem and informational support, and by more tangible means such as providing educational materials (Schultheiss, Kress, Manzi, & Glasscock, 2001).

A fairly large body of research provides support for the role of mothers in women's career orientation (O'Brien & Fassinger, 1993) and vocational choice (Felsman & Blustein, 1999). Adolescent girls were more likely than boys to report that their mothers provided positive feedback, supported their autonomy, and were open to discussions about career decisions (Paa & McWhirter, 2000). The career orientation of adolescent females is influenced by a complex interplay of ability, agenting characteristics, gender-role attitudes, and the relationship with their mothers (Rainey & Borders, 1997).

Computer use. Experience with computers is associated with positive attitudes toward computers (Dryburgh, 2001; Lips & Temple, 1990) and interest in computers (Lips & Temple; Shashaani, 1997). High-school programming experience has also been shown to be a significant predictor of women's success in computer science at the college level (Bunderson & Christensen, 1995). Enjoyment with using computers is associated with an interest in majoring in computer science (Lips & Temple).

Attitudes. Research is somewhat mixed about the connection between attitudes about the nature of work in computer-related fields and women's interest in IT and related fields. Some research suggests that negative stereotypical views deter women from enrolling in computer-related fields (Breene, 1993; Fountain, 2000), while other research indicates that women have more positive views than do men about computer technology (Ray, Sormunen, & Harris, 1999). Gender differences in attitudes about computer technology have probably narrowed as the gender gap in access to computers has virtually disappeared in the last decade.

MAIN THRUST OF THE ARTICLE

This article summarizes key findings of a theoretically driven, causal model that the Women and Information Technology (WIT) team developed to predict women's interest and choice of careers in information technology. This model reflects the results of a path analysis and predicts 27.4% of the variance in women's interest and choice of computer-related fields. The model was refined through analysis of the responses to three revisions of a questionnaire, *The Career Decision-Making Survey*, administered between 2002 and 2005 in three waves to high-school and college women in rural and urban locations in the mid-Atlantic region (N=1621). The findings discussed here are from 373 high-school and college women completing the questionnaire in the fall of 2004 and spring of 2005. The theoretical implications of the model were further extended through the analysis of interview data with high-school and college women (N=151). The analysis of data collected through one-on-one interviews with female high-school (N=53), community college (N=39), and university (N=59) women attending public schools in urban and rural locations throughout the mid-Atlantic region added to the theoretical development of the model.

Characteristics of questionnaire respondents. The sampling technique of purposefully targeting students enrolled in a balance of rural and urban institutions produced a diverse pool of respondents. Slightly more than half of our respondents (50.7%) are racial minorities. Nearly 40% have parents whose highest level of education is high school or less (37.3% mothers, 38.1% fathers), reflecting that more than one third of our sample is probably from middle- and low-income families. More respondents were enrolled in high school (N=293) than in college (N=80).

One exogenous variable (race) and four mediating variables (parental support, computer use, positive attitudes about the attributes of IT workers, and sources of career information) have direct effects on the dependent variable: IT career choice and interest. Each of these variables consists of a number of questionnaire items that were confirmed through factor analysis. All of the variables had a reliability index (Cronbach's alpha) of 0.60 or better, with most exceeding 0.70.

KEY VARIABLES IN THE MODEL

The model captures cognitive and social dimensions of how high-school and college women make career decisions. In most cases, respondents indicated their agreement to questionnaire items using a four-point Likert scale (1=*disagree*, 2=*slightly disagree*, 3=*slightly agree*, 4=*agree*).

The dependent variable, IT career interest and choice, contains seven questionnaire items. Students indicating interest in careers in computer-related fields were likely to agree that they had some familiarity with the nature of IT work, knew people working in the field, derived satisfaction from using computers, and perceived that their parents would consider IT a good choice of a career field. When all factors were controlled, minority women expressed significantly more interest in careers in computer-related fields than did Caucasian women.

The four mediating variables in the model that directly impact interest in a career in a computer-related field are the following.

1. Parental support
2. Computer use
3. Positive attitudes
4. Sources of career information

Four variables related to the process young adults use to make career decisions are at the center of our model. One of these variables, the number of people consulted about career options, had a direct and significant impact on an interest in and the choice of an IT career, but the direction of the relationship was not what we expected. In general, women who expressed interest in IT as a potential career choice perceived that their parents supported the choice, but the choice was not significantly impacted by information from other sources. Most surprisingly, the fewer contacts respondents had made with various types of people to discuss career options, the more likely they were to express interest in careers in IT. This indicates that individuals are expressing interest in IT with minimal information from people outside their immediate family. This supports the conclusion that one of the biggest challenges facing educators who want to promote women's interest in IT is to develop a portfolio of strategies that engage young women in thoughtful reflection about career options that are good matches for their values, skills, and interests.

Key elements of each of the four principal variables in our statistical model are discussed in the following section. Each of these offers insight into the types of interventions educators might design to promote interest in IT-related majors.

Parental Support

Our findings support previous research that documents the central role of parents in career decision making for high-school and college women. In our model, parental support includes nine questionnaire items relating to perceptions that parents support the importance of a career and encourage career exploration, as well as agreement with the belief that parents have an idea of what would be an appropriate career choice. Students who express interest in IT careers believe that their parents support their career choices.

Parental support had a direct and positive impact on career information-seeking behavior, a central part of our model. Parents directly influenced three attitudes and behaviors related to seeking career information. These were, first, how likely respondents were to seek input from others when making an important decision; second, the credibility they awarded to the several different groups of individuals as sources of career information (parents, family members, friends, teachers, counselors, and employers); and, third, how often career options had been discussed with the same groups of people. Not surprisingly, the level of education achieved by the respondent's mother and father had a positive and significant impact on parental support.

The direct relationship between parental support and interest in an IT career supports the idea that sharing career information with parents or involving them, particularly mothers, in educational activities is likely to have a positive impact on women's IT career interest.

Computer Use

It is no surprise to discover that computer use has a direct and positive impact on women's interest in careers in computer-related fields. What is unusual about our findings, however, is that for women, interest in IT careers is significantly related to their amount of computer use, but not necessarily their type of computer use.

The respondents to our questionnaire gauged how often they used different types of computer applications, ranging from simple communication through e-mail and instant messaging to more sophisticated purposes, such as the development or design of Web pages. Regardless of the application, the more time respondents spent using the computer, the more likely they were to have positive attitudes about the attributes of IT workers and to consider IT as a possible career option.

Our findings add empirical support for interventions that provide opportunities for hands-on use of many kinds of computer applications. It is very likely that experience and comfort with more sophisticated computer applications are associated with the ability to persist in a computer-related major or career, but they are not, according to our findings, a prerequisite for preliminary interest in a computer-related major.

Positive Attitudes

Previous research supports the idea that negative or stereotypical attitudes about workers in the IT-related fields explain some of the reluctance women express about computer-related careers (Ahuja, 2002). Findings from our model reveal a somewhat more nuanced pattern. Positive, not-stereotypical views had a direct positive impact with an interest in a career in IT. Women with positive attitudes were significantly more likely to express interest in IT careers.

Women who expressed an interest in computer-related fields were significantly more likely than other women to believe that IT workers are interesting, hard working, smart, and creative. The importance of this finding is magnified because not only did positive attitudes about the attributes of IT workers have a significant positive impact on interest in a career in IT, they also had a significant direct effect on two other variables in the model: computer use and receptivity to advice about IT careers. Respondents with positive attitudes about the attributes of IT workers used computers more frequently and were more receptive to career advice than those who used computers less frequently.

Educational programs that effectively communicate the idea that working in a computer-related field is interesting and creative are likely to translate into gains in the number of women expressing interest in careers in IT.

CONCLUSION

Our model demonstrates that high-school and college women who express interest in careers in computer-related fields share three central characteristics, all of which can be addressed through educational programs.

1. They perceive that parents support IT as an appropriate career choice.
2. They use computers frequently and in various ways.
3. They have positive attitudes about the attributes of IT workers.

Despite the fact that women responding to our questionnaire were significantly more likely than their male counterparts to seek career information from several sources, this was, much to our surprise, negatively related to IT career interest and choice. Most surprisingly, the fewer interactions our respondents reported about career options, the more likely they were to express interest in IT careers. This supports findings from our qualitative data and suggests that an expression of interest in a career in the IT field is often made with little concrete information from sources outside of the immediate circle of trusted friends and family members. This finding does not bode well for the likelihood of long-term persistence in the field.

It is our conclusion that one of the biggest challenges facing educators who want to promote women's interest in SET fields is not simply to develop strategies designed to ensure widespread dissemination of career information about sex-atypical careers. Ensuring women's engagement in a deliberative process about choosing a career requires the creation of a portfolio of developmentally appropriate strategies that engage young women in thoughtful reflection about career options that match their values, skills, and interests.

FUTURE TRENDS

Some researchers have struggled to understand why even proactive efforts to recruit women to degree programs in computer science are frequently not successful (e.g., Cohoon, Baylor, & Chen, 2003). Findings from this research project suggest that recruiting women to IT majors and careers requires considerably more ingenuity than simply delivering information in an engaging way. Recruiting efforts are most likely to be successful when they include a long-enough period of engagement during which participants can begin to feel a sense of affinity and trust for those that guide them.

NOTE

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KEY TERMS

Direct Effect: In a statistical model, it is a variable that impacts the dependent variable, or the variable being predicted, in a direct and statistically significant way.

Exogenous Variable: A variable assumed to be outside of the scope of the statistical model to predict.

Indirect Effect: In a statistical model, it is a variable that impacts the dependent variable, or the variable being predicted, indirectly through another variable.

Information Technology: Refers to a variety of jobs that involve the development, installation, and implementation of computer systems and applications. Careers in IT encompass occupations that require designing and developing software and hardware systems, providing technical support for computer and peripheral systems, and creating and managing network systems and databases (Governor's Commission on Information Technology, 1999).

IT Career Interest and Choice: The dependent variable in our statistical model that identifies the characteristics of respondents who either express an interest in a career in IT or have already made a choice to pursue a career in IT.

Parental Support: Parental support for a career and for career exploration.

Path Diagram: Represents results of a path analysis by showing the relationship between variables derived from theory in the form of a diagram. The variables in the model are connected by paths or directional arrows that display regression weights.

Reliability: Measures that reflect the consistency or dependability of a variable or construct.

A Psychosocial Framework for IT Education

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INTRODUCTION

The most recent U.S. national statistics available indicate that among those earning degrees in engineering in 2000-2001, women made up only 18% of bachelor's degrees, 21% of master's degrees, and 17% of doctorates (NCES, 2003). A similar pattern emerges among those earning degrees in computer and information sciences, with women awarded only 28% of bachelor's degrees, 34% of master's degrees, and 18% of doctorates in those areas in 2000-2001 (NCES, 2003).

These and related statistics suggest a continuing gender imbalance in engineering and computer and information science education, academic pathways that lead to careers which are among those traditionally accorded higher prestige and greater financial reward than traditionally "female" occupations (Kennelly, Misra, & Karides, 1999). The situation is particularly dire in computer and information science education. According to testimony at a recent congressional hearing, although the proportion of computer science graduates who were women increased steadily from 14% in 1972 to 37% in 1984, from 1984 to 2000 those numbers began to steadily decline again and are currently at less than 28% (Borrego, 2002).

If computer and information technology education draws only from the 49% of the population which is male, the resulting gender imbalance is bound to translate into a shortage of trained IT personnel to fill existing positions. The aging IT workforce means that employers will need to fill not only new positions but those vacated by retiring personnel over the next twenty years (Jackson, 2004). The sheer number of technical professional positions to be filled now and in the foreseeable future makes it imperative that we tap the entire pool of young talent through early implementation of formal and informal strategies that encourage girls and young women to develop technical interests and skills and to enter technical training and post-secondary computer and information science education programs.

BACKGROUND

Although the factors associated with educational and career choices are complex, the relatively small numbers of young women choosing to pursue education and careers in technology and engineering may be directly related to *psychosocial* factors, such as a lack of professional *role models* (Smith, 2000). In simplest terms, a role model is someone who shares substantial characteristics of the observer and by extension is doing something the observer could do. The presence or absence of same-sex role models may transmit to individuals a powerful message regarding the *gender congruity* of various pursuits, including education and careers. The absence of female role models in computer and information science therefore limits the number of young women entering these education pathways, resulting in a situation where neither the academic presence nor the corporate representation of women increases.

As mentioned in the previous section, the number of women in computer and information science fields is not increasing and has, in fact, decreased over the last twenty years (Women Yield High-Tech Field, 1998). Insufficient numbers of women IT academics and field practitioners means that newcomer access to senior women who can provide *psychosocial* and *career mentoring* (Johnston, 2002) is adversely impacted. Of course, young women coming into the IT education and career pathways can and do find mentors among academics and field practitioners of both sexes. However, in light of the minority status of women as a group in computer and information science, female mentors may be better equipped to guide new female entrants through the social and professional vagaries of the educational and career process (Smith, 2000). Senior women who have successfully weathered the process may be able to impart specialized knowledge regarding *coping* and adapting, especially important for newcomers. Minimal presence of female mentors may be one cause of the previous decade's female exodus from computer and information science fields.

GENDER IDENTITY, CULTURAL EXPECTATIONS, AND COGNITIVE SCHEMAS

That there are proportionately fewer women currently working in or choosing to enter computer and information science fields may be due in large part to gendered cultural expectations (Smith, 2000) and the *gender schemas* associated with them.

Kohlberg's (1966) theory of development describes the acquisition of *gender constancy* as a process not completed before children reach the age of five or six. It is at this point in psychosocial development that children understand that being male or female is immutable, just as they begin to integrate the gendered cultural expectations that have swirled around them since before birth and to internalize a *gender identity*, that is, a strong sense of what it is to be male or female.

From these pervasive expectations, culturally derived cognitive *schemas* are built. At this point, children begin to categorize their world in more constrained ways, using schemas or frameworks into which information can be sorted automatically in order to efficiently organize and process the huge amount of incoming information about the world. Gender schemas are comprised of experienced and culturally defined elements of human "femaleness" and "maleness," including aptitudes and behaviors, for comparison to anything that might be defined as or characteristic of female or male.

Perceptions of *gender roles* are culturally driven (although there is a fair amount of cross-cultural correspondence) and so the resulting gender schemas for "maleness" and "femaleness" are generally shared by members of the same culture. In the case of a particular educational or career path, a culture defines the skills required for associated pursuits, and these skills are often associated with aptitudes believed to be inherently and dispositionally "male" or "female." In this way, certain careers come to be perceived within a culture as traditionally appropriate for women (e.g., "nurse") or for men (e.g., "engineer"). These culturally defined *gender role schemas* are internalized by individuals over the course of their development, reinforced along the way by the popular media and by the attitudes and behaviors of parents, teachers and peers (Smith, Jussim, & Eccles, 1999).

The cultural expectations regarding various groups can rise to the level of *stereotypes*, setting the stage for individual members of that group to experience what is known as *stereotype threat* (Steele, 1995, 1997). In performance situations where individuals are aware that a negative group stereotype exists, the anxiety produced can adversely affect performance for a variety of reasons unrelated to ability (Steele, 1995, 1997; Threats Within, 2004). Girls and young women find themselves in a stereotype threat situation any time they are performing with technology in general and computers in particular (Cooper & Weaver, 2003). The anxiety produced may negatively affect cognition and performance, resulting in performance that does not truly reflect abilities. Girls may come to doubt their own abilities and out of a need to preserve their own self-esteem they may then dissociate from technology, embracing the prevailing gender schemas that inform us that this is a male domain and that technology competence is unimportant for females.

Impact of Gender Role Schemas on Educational Choices

Given the strength and pervasiveness of cultural expectations, it comes as no surprise that gender-related schemas become quite rigid over time. Such appears to be the case with computer and information science. In western cultures particularly, skills and aptitudes associated with these educational and career paths have come to be perceived as traditionally male, and as a result, girls and young women may not consider computer and information science appropriate pursuits for females (Colley, Gale, & Harris, 1994). The very "culture" of computers has become associated with male values (AAUW, 2000), forcing girls to choose between technology pursuits and their basic gender identity or "femininity."

While young people can and do choose "non-traditional" education and career paths, it is clear that cultural expectations drive and constrain such choices. It can be extraordinarily difficult to successfully travel a path that defies the culture's expectations regarding gender appropriateness. Some "non-traditional" education and career paths may be retained as viable options for males and females through high school and even beyond college entry. A student's prior lack of interest does not substantially preclude becoming a biologist or chemist. However, the choice of post-secondary computer and information science education may be largely contingent on long-term interest and skills development, which familiarize the individual with IT culture and make these pathways recognized and viable options.

Unlike traditional sciences such as biology and chemistry, computer and information science courses, even basic ones, are not offered in all high schools; in schools that offer such classes students are not required to take them. Given that these courses are often elective, the students who choose them are more likely to be those who have had a longstanding interest in computers and technology. As noted above, gendered expectations around education and careers virtually guarantee that high school students with a history of interest in computers are overwhelmingly male and white. Male students are more likely than female students to have a computer in their room at home, and to have participated in pre-high school and pre-college extracurricular computer activities such as camps, clubs and competitions (Clarke & Teague, 1996). As a result of gender differences in early technology-related experiences outside of school those taking basic and advanced placement computer and information science courses in high school are overwhelmingly male (Bitten by the Tech Bug, 2000; Clarke & Teague, 1996; Cooper & Weaver, 2003; NCES, 2004). The gender discrepancy persists after high school graduation, with many fewer women than men enrolling in computer and information science courses when they reach college (Cooper & Weaver, 2003).

Early Intervention in IT Education

The psychosocial framework as outlined in the previous sections, including gender role expectations and gender differences in early technology experiences, makes it desirable that interventions to increase the presence of women in the information technology workforce be focused on influencing the developmental process at the point at which girls are acquiring gender identity and an awareness of gender role expectations. Given the young age at which these processes occur, to be effective such interventions must be made at the earliest possible point in girls' formal and informal education.

Perusal of the 2003 and 2004 proceedings of the National Science Foundation's ITWF & ITR/EWF Principal Investigator Conference suggests that many current programmatic approaches to increasing gender equity in computer and information science, particularly initiatives involving institutions of higher education, focus on young women of high school and college age. There appear to be many fewer such programs targeting girls of middle or junior high school age, and still fewer programs that are structured to reach girls in elementary school and that could truly be described as early interventions. Absent entirely appear to be programs that offer a continuum of technology experiences for girls from elementary school to high school. The lack of early, long-term programmatic interventions may be due in part to the challenges and complexities of working with very young populations, as well as to the challenges inherent in building and sustaining partnerships with school districts, families, and community organizations over a period of more than a few years. However, these are obstacles that can be and must be surmounted because early intervention is essential to achieving equity in IT.

The overall goal of early intervention projects must be to influence girls' perceptions of gendered cultural expectations, and to support the development of gender role schemas that include female traits as compatible with computer and information science. Recent research suggests that young women may steer away from careers in technology not because they lack interest in technology-related activities as a whole, but because they perceive the culture of technology to be incongruent to their gender identities. That is, they perceive technology to be a male culture, unappealingly boring and antisocial, peopled with "computer geeks" working in isolation on projects that have little relevance in real terms to the advancement of the human condition (AAUW, 2000; Bitten by the Tech Bug, 2000). A *gender normative* technology environment, one in which a community of girls and women intersects with technology on a continuing long-term basis, offers girls an alternate gender schema that links being female with being technical.

In addition, the well-established importance of role models and mentors makes it clear that if we are to attract more young women to the technology and engineering fields, we must provide very early and ongoing exposure to female role models and mentors in these fields (Bitten by the Tech Bug, 2000). For girls, early and ongoing exposure to female role models and mentors illustrates that the pairing of women and technology is both natural and desirable.

FUTURE TRENDS

Given the developmental implications of the technology gender gap, future research must focus more on enhancing gender equity in IT education through development of early interventions within a psychosocial framework. Many gender equity in IT research projects incorporate potentially effective strategies, but without explicitly setting them in a psychosocial framework that focuses on influencing construction and acquisition of girls' gender schemas. Given the similarities of approach among projects, it is clear that we have learned through our assessments that certain components "work," that is, we can engage girls and young women in computer and information technology activities at certain points in their development, and they express interest in and enjoyment of those activities. Future research might do well to start from broader theoretical frameworks which will enable assessment to go beyond participants' apparent, but often fleeting, interest and enjoyment to not only identify what is "working," but also to define from a psychosocial perspective what "working' means, and why and how some strategies appear to "work" better than others. In this way, we may move toward a higher degree of confidence in identifying strategies that can be generalized across populations to enhance equity in IT education.

Given a psychosocial framework, we must direct our IT education research toward exploring intervention at critical early developmental junctures (Brown, 2001). We have often focused on developing projects that engage girls in middle and high school in technical activities, which they clearly enjoy, but we have not paid as much attention to girls' relationships with technology. In other words, many of our interventions focus on technical learning, unlike the *Girl Power 21st Century* project, which focuses on girls' evolving relationship with technology in the context of their gender identity development.

We have seen that no matter how enjoyable technical experiences are and no matter how female-friendly the environment in which they take place, merely exposing girls to technical experiences does not with any degree of certainty translate into more women entering IT education and career pathways. In the future, it might be wise for researchers to utilize a more developmental approach, intervening early and providing a continuum of experiences that may influence the development of gender schemas, as well as attitudes regarding what is and is not a gender appropriate academic or career interest. A necessary parallel focus on influencing attitudes of family members and other influential individuals in girls' social networks, such as educators and peers, falls quite naturally within this framework (Smith, Jussim, & Eccles, 1999).

CONCLUSION

Early intervention set in a psychosocial framework is a promising direction for future research. We have long accepted that early intervention is necessary to achieve our goal of equal educational opportunity (e.g., Head Start programs), and equity in IT education requires us to think in similarly developmental terms. We know also that achieving a "critical mass" of women in any field facilitates change, as demonstrated by changes in the practice of medicine and, to a lesser degree, law, and academia. Only at the point of critical mass do women have the power to begin influencing a work culture from within. By intervening early in the psychosocial process that limits perceived career choices for girls, we will be helping girls to develop into young women who have incorporated different expectations into the way they view the world of work. In this way, we will enable them to introduce new cultural norms, and to create change from within the IT education and work culture, even before women have achieved that "critical mass" presence.

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KEY TERMS

Career Mentoring: Mentoring that is in the form of coaching, protection, and sponsorship and that advances the mentee's career development and which prepares the mentee for advancement.

Coping: Refers to individual behaviors in response to environmental stimuli and can be individually adaptive (resulting in better functioning) or maladaptive (resulting in unchanged or worse functioning).

Gender Congruity: The degree to which a behavior or set of behaviors is perceived to align with the culturally defined female or male gender schema.

Gender Constancy: The transition between knowing the labels "girl-boy" and recognizing that the labels are immutable which occurs around the ages of 5-6.

Gender Identity: An individual's awareness of her/his own gender and its implications, i.e., what it means, in a context that includes culture as well as biology, to be male or female.

Gender Normative: Describes activities and behaviors that are perceived to be "normal" for females or males, and which serve to reinforce gender roles within a given culture.

Gender Role: A set of behaviors and attributes accepted within a cultural context and internalized by the individual as being appropriately linked with one sex or the other.

Gender Role Schemas: Organized sets of culturally derived beliefs and expectations about males and females that provide a framework for efficient cognitive processing of information.

Psychosocial Mentoring: Mentoring that is in the form of role modeling, counseling, and friendship, and that enhances the mentee's sense of competence, identity, and work-role effectiveness.

Psychosocial: Pertaining to the psychology of social interaction.

Role Model: Individual perceived as an exemplar to be emulated in a specific area.

Schema: Organized set of beliefs and expectations that guide information processing about a particular thing.

Stereotypes: Oversimplified beliefs about a group of people, generalized to individual members of the group based on uncritical judgments.

Stereotype Threat: Anxiety and apprehension experienced by individual members of minority groups in a setting where the individual's performance or behavior has the potential to validate an existing cultural stereotype.

Pushing and Pulling Women into Technology-Plus Jobs

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INTRODUCTION

This article discusses the causes and implications of an empirically observed tendency to channel a disproportionate number of female computer professionals working in IT companies into what we term *technology-plus* positions. Technology-plus positions are positions requiring technological knowledge and skills but also containing a significant "non-technological" component. The most common such positions are project and group management, but also some sales/business development tasks, technical and specifications writing, and positions entailing substantial client contact can also be included in this category. Channeling a disproportionate number of female computer professionals into technology-plus positions is seen as evidence of gendered "segregation"[1] at the occupational sub-specialization level in the high end of the IT industry. This process is primarily based on horizontally differentiated positions and tracks rather than vertically hierarchical positions, though as argued below, a particular status hierarchy plays a central role in this process. Space constraints mandate sacrificing depth for breadth in making the argument here (see also Davies & Mathieu, 2005).

BACKGROUND

Studies on occupational segregation in the IT industry have documented the general gap between men in the upper and women in the lower echelons of the industry (Millar & Jagger, 2001; Pantelli, Stack, Atkinson, & Ramsey, 1999). Less attention has been paid to differentiation and segregation processes among computer professionals in its higher reaches. There are notable exceptions. Wright (1997) has quantitatively studied the issue in the U.S., concluding that some, but insufficient inroads have been made. Wright and Jacobs (1994) strike an optimistic tone regarding the prospects for sex integration, noting that males are not fleeing the occupation as more women move in. Fondas (1996, p. 284) shares this optimism. Woodfield (2000), however argues that sex-integration of the branch has been optimistically foreseen in three periods in the comparatively brief history of computing, but never realizing the optimistic projections. Some qualitative research has also been conducted in the field. Woodfield's (2000) case study in England found that even in an organization with progressive gender policies and that praises hybrid skills, men were still systematically advantaged and advanced past women. Tierney's (1995) study of an Irish software unit displays how the informal contacts between senior and junior men in the organization open avenues for advancement via informal access to information and currying favoritism based on in-group membership revolving around selectively male interests (football, drinking). In national statistics and four case studies, Pantelli et al. (1999) also find evidence of barriers for the advancement of women in the Scottish IT sector, with few women moving into management. To a certain extent, we find the same with regard to *senior* management. However, we found a different phenomenon at the middle management level—where women were consciously moved into technology-plus positions.

The empirical conclusions presented here derive from a research project on sex and gender equality/inequality in the IT sectors of Sweden and Ireland carried out from 2001-2004.[2] A total of 84 interviews were conducted with male and female employees and managers in eight companies in Sweden and five companies in Ireland. All but one of the companies fall into the NACE 72 category and ranged in size from seven to several thousand employees. In another part of the study, a total of 49 telephone-interviews were conducted with two cohorts of *women* who had studied computer science at a major Swedish university in the early and mid-1990s. The qualitative career choice and career history data was used to uncover processes and mechanisms which lie behind outcomes that are often construed as "free" choices (see Bertaux & Thompson, 2003; Evetts, 1993; Reskin, 2000, 2003).[3]

WOMEN IN TECHNOLOGY-PLUS POSITIONS: THE EVIDENCE

National occupational statistics are not sufficiently differentiated to see if observations from our companies are representative for the branch as a whole in Ireland and Sweden. This is because the technology-plus positions that actually are *positions*, such as group, unit, or line manager are often grouped together with other comparable positions for statistical purposes, and that others are *roles* or *functions* within a broader undifferentiated category, such as project leaders among "computer specialists." Even when statistical material is available down to the *positions* of group and project leader, the "lack of a standardization of job titles in IT" (Pantelli et al., 1999, p. 173) makes comparison difficult.

Evidence for the preference for and actual over-representation women in technology-plus positions comes from three sources in our study. First, our Irish and Swedish informants, male and female, employees and managers, reported an over-representation of women in technology-plus positions in their companies and in the branch general. A corollary to this is when asked if men and women tend to move into the same or different specializations, it was stated that women tend to move into project or group management, and seldom if ever into leading-edge technical specialist positions.

Secondly, data we collected about employees, titles, jobs and from organizational charts corroborated our informants' observations. Group leadership in Sweden was distributed fairly consistently on a 50-50 basis in Sweden (compare with a general presence of women in these companies at about the national average of 25%); while in Ireland it was slightly less. Project leadership appeared as both a formal *position* and a *role* and thus was more difficult to gauge, but the rough estimate in our companies ranged from 40-60% women, significantly higher than the proportion of women in qualified computer jobs in the companies in general.

The third piece of evidence is the rhetorical support for the recruitment and "appropriateness" of women in such positions. A characteristic comment was made by a female Irish engineer by training, currently working as a project staffer: "To be honest, what I've seen here [at company X] is that women are much better at project leadership than men are…Because project leadership requires you to be very disciplined and organized…women are more systematic. If you look here most of the women here are project leaders. They [senior management at company X] like women to do project leader roles." The "fit" between women and technology-plus roles is based on "matching" skills associated with central tasks in these roles with certain basic characteristics commonly ascribed to men and women. In addition to the culturally based notion that women have better "soft" or communication skills, a number of more specific attributions were ascribed to women—having a holistic orientation; a client/user's perspective; being more systematic and organized and preferring simple, functional solutions to "technological overkill;" and men—jumping into solving particular problems without seeing the "big picture," being oblivious to client/user needs, and being so fascinated by technology that "the more sophisticated the better" was the guiding theme in their work. It was also contended that women tolerated ambiguity or "fuzziness" better.

WOMEN IN TECHNOLOGY-PLUS POSITIONS: SEGREGATION, INTEGRATION, FEMINIZATION?

Following on the point made directly above, technology-plus positions are conceptually *feminized*, but empirically or de facto integrated, as there are roughly as many men as women in such positions. This may be due to the fact that some males are attracted to such positions, or the relatively low number of women in the branch, but it shows that despite the conceptual feminization of these positions, males are not denied access to these positions. Technology-plus is constructed as feminine but it is not a female sphere. This is possibly due to the gender elasticity of the concept of management, which Wajcman (1998) argues is prototypically masculine. Technology-plus *isn't* gender ambiguous–it was presented as highly gendered. However, positions that involve management and sales can alternatively be constructed as masculine by drawing upon general, branch-external gendered associations.

Structural factors facilitate this phenomenon. One is the tripartite sub-specialization process in the branch: (1) becoming a (leading-edge) technical *specialist*; (2) becoming a well-rounded technical *generalist*; or (3) going into project or group management. While these are not irreversible choices, practitioners in the field see them as slippery slopes—once one had embarked on one of them, it is difficult to change tracks. The *de facto* rigidity of the specialization process makes the channeling of women into technology-plus pernicious; a fluid flow between the tracks would be less troublesome. Another factor is that technology-plus positions are usually filled by internal labor markets as they often require knowledge of a company's products, previous projects and internal resources, or industry-wide platforms or environments.

Another important "structural" factor is that this is where "holes" or openings exist in the companies studied. These holes are created by few (men and women) in the branch being interested in these positions. Personal interests tend overwhelmingly to lie in working with technology, and this is buttressed by the predominant cultural, social and organizational arrangements in the branch. These holes result from a "*reverse hierarchization*" of practical/technical and managerial/leadership roles and positions in the branch. We found a *strong* opinion in the branch that *technology* is what is important; especially the forefront of technological creation and innovation is what is *prestigious* and accords *status*. Moving away from technology, even if it means acquiring planning and managerial "power" entails a drop in status. In a branch where technical knowledge, innovation and creation are the highest values, "repetitive" and "non-productive," non-technological tasks such as management were seen as necessary evils—and referred to derogatively as "administration" and "overhead"—and were to be avoided if at all possible, even if one could earn slightly more. In questioning whether money compensates for what is lost, one Swedish female group leader with 15 years branch experience stated: "You get paid the same, so why take the responsibility?…One gets paid a little bit more, but it doesn't make a difference." Thus, though these are "management" and "leadership" and organizationally vital, well-paid positions, they are culturally "peripheral" and thus it is less surprising to find women there (Bagilhole, 2002; Reskin & Roos, 1990).

PUSHING AND PULLING INTO TECHNOLOGY-PLUS POSITIONS

Causes

Both push and pull factors are at work here, and sometimes it is difficult to separate them. Push causes are generally factors that operate negatively, consist of barriers, limit choices, and push individuals in certain directions. Pull causes operate via attraction. Several push causes were identified in our study. Some women reported not being able to get onto the specialist track due to not being given the opportunity to show what they were capable of. One female Swedish programmer from our cohort study stated: "As a woman it isn't easy to get other [more technologically advanced—author] tasks. They often remain sitting there with the routine jobs, while guys are more aggressive and get to do the more exciting things. Men are more self-assured and display themselves as more "clever" even if they really aren't." While it is difficult in our (non-ethnographic) study to specify why far more males (though far from all males) get on the pure and advanced technology tracks, its clear that processes of accretive, cumulative advantage and disadvantage (Bielby & Bielby, 1996) shape outcomes with women frequently being left with more routine tasks. Those who initially obtain more advanced tasks tend to "prove" their capability and continue to acquire such tasks in the future and vice versa (Trauth, 2002, p. 111). The likely gendered origins of these personal trajectories are unacknowledged and quickly eradicated as all assessments become seen as based on what the advantaged and disadvantaged have "actually" proven or (not) done. As large numbers of women are condemned to routine tasks, the opportunity to develop and "rise" by going into technology-plus positions becomes an attractive option. Push begins to appear as pull.

Pure technology positions were often described as being set in unattractive work environments: socially and physically isolated, sedentary and monotonous—"churning out code on one's own all day" and the description "asocial" arose in several interviews.[4] While some factors were ascribed to "branch pressures," most were frequently seen as both unattractive and unnecessary by a number of women and men. Why these environments were not changed was explained as due to a lack of demand for change by those (primarily men) already there. Another push cause is the absence of women already in these positions. This operates as a social reproduction factor (Blackburn, Brown, Brooks, & Jarman, 2002)—sustaining a barrier by not providing women with "social leads" into the areas where they are underrepresented and many social leads into areas where they are over-represented.

On the pull side, these holes or organizational needs open up "opportunities." These "opportunities" are portrayed as attractive for personal and professional development; an opportunity to engage in more "social" activities than endless coding, an escape from unstimulating routine tasks, and to attract positive attention by doing something important for the company as a whole. The conceptual feminization of technology-plus positions leads to the argument that women are best suited for these positions, and can make a greater contribution here. Based on company needs and the gendered conception of skills, women are steered towards "opportunities" in technology-plus positions. Most of the women (and men) we interviewed in technology-plus positions were aware of the trade-offs entailed in going this route, and *still* expressed their preference for technical work, while reconciling themselves to the position they have or keep their dream of "returning to the technical side" later alive.

Another pull factor reported was that in technology-plus positions it's easier to plan one's time as one isn't hit by enormous workload waves as project deadlines approach to the same extent as those with purely technical tasks. This can be understood as an industry-specific reversal of Crompton's (2002; Crompton & Harris, 1998) practitioner-managerial career argument, where in the IT sector project and group management resemble in central characteristics "practitioner" positions in other branches and vice-versa.

Consequences

From a sex-integration perspective, several questions can be raised. On the positive side, profiling technology-plus positions may open inroads into the branch that are more attractive to a broader range of women. Carving out a niche within the branch may serve to crack the "technical" façade of the branch, something that is frequently portrayed as scaring girls and women away from the branch and educational programs leading to it.

However, there are disturbing effects associated with this phenomenon. Shunting women into technology-plus appears to play a role in facilitating the exit of skilled, experienced women from the sector. One of the "mysteries" among our informants was "why are there so few women over 40 in the sector?" As one Swedish female consultant put it "I entered the sector with 10 female classmates from university ... and I am the only one left in the branch" after almost 20 years.[5] As women move into technology-plus positions, the "plus" activities afford them the opportunity to develop and document more broadly applicable skills. Whereas programming and systems work is a rather narrow skill set, management and leadership, client relations, etc., are applicable in a wider variety of settings. Simultaneous to developing and documenting these skills, technology-plus positions often entail contact with other organizations (read: potential employers) frequently outside of the IT branch. Losing senior women also means losing social leads into and through the branch for other women.

FUTURE TRENDS AND CONCLUSION

Future action depends upon how this phenomenon is documented in further research and the significance and meaning its implications become associated with. Multiple scenarios are possible. One sees this "natural tendency" for women to gravitate towards these functions as unproblematic. Even if recognized as a distinguishable pattern, if its causes are attributed to individual choices or preferences (Hakim, 2000), then it is not problematic and should be left alone. Another scenario entails exploitation of this phenomenon to draw more women into the sector and educational programs oriented towards specifically filling technology-plus positions–a strategy of "integrating more women into the branch" via greater and more explicit occupational or role segregation. More critical perspectives might see the problematic aspects of the phenomenon. From an individual choice perspective it can be argued that shunting women via gendered processes into these jobs and tasks denies them the opportunity to truly make free choices about career paths. If one's primary concerns are primarily with increasing the numbers of women in the branch, the contribution of this process to exit might be the utmost concern. If one's interest is in the prospective (business and/or social) benefits of mixed/balanced workplaces and workgroups, the phenomenon may or may not cause alarm. If having female project leaders leads to more openness in the project group, a greater willingness to flag when problems are encountered, collective solution seeking, an increased sensitivity to client and user needs, etc, then the current division of labor might be fine. However, if one is interested in the prospective benefits of diversity/integration at all levels and in all groups and communities within the organization, the current occupational segregation fails to realize these ambitions.

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KEY TERMS

Hybrid Skills: Woodfield (2000) defines hybrid skills as combining technical and social skills and the hybrid worker as: "as much a conduit of information and catalyst of group dynamics as a deployer of purely technical skills" (p. 35).

Internal Labor Markets: Recruitment to positions that occurs within specific parameters, such as a firm, sector or profession.

IP: Intellectual property: An idea or design that can be sold or leased to another company for exploitation or development.

NACE Codes: NACE is a pan-European system for classifying companies or organizations based on their area of business activity. The categories relating primarily to computing activities are K.72.

Occupation: A "set of jobs in different firms that employers and government officials consider equivalent" (Tilly & Tilly, 1994, p. 289).

Occupational Segregation: The predominance of some distinguishable group in a given occupation. "Predominance" is a variable term, ranging from a marginal majority (for example 60%) to total dominance (100%). See Reskin, (1993, p. 244-245).

Technology-Plus Positions: Positions or roles where technological skills and knowledge are combined with non-technology tasks such as management, leadership, sales, client relations, technical and specifications writing.

ENDNOTES

1. The "segregation" process results in integration or sex balance in these positions–see below.
2. Funded by the Swedish VINNOVA foundation (project number 18327-1). Karen Davies and Katja Bierlein also worked on the project.
3. See Davies and Mathieu (2005) for a deeper description of the project, methodology and results.
4. However, our female informants reported and interest in technology and a desire for stimulating work tasks on par with or exceeding our male informants, in concurrence with Pantelli et al. (1999) and Korvajärvi (2004).
5. Nine of the ten were still in full-time employment in other branches.

Questioning Gender through Deconstruction and Doubt

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INTRODUCTION

Questioning gender can lead to a reformulating research into: "Why did the hard core of methods, theories and practices of the informatics discipline and domain become a symbol for masculinity?" and "Why is femininity constructed as situated only in the discipline's soft border of the interaction with the users of ICT-products?" In the view of Judith Butler, questioning gender is a strategy to disrupt the obvious acting of every actor, designers and users in the informatics domain:

The abiding gendered self will then be shown to be structured by repeated acts that seek to approximate the ideal of a substantial ground of identity, but which in their occasional discontinuity, reveal the temporal and contingent groundlessness of this "ground." The possibilities of gender transformation are to be found precisely, in the arbitrary relation between such acts, in the possibility of a failure to repeat, a deformity, or a parodic repetition that exposes the phantasmatic effect of abiding identity as a politically tenuous construction. (Butler, 1990, p.141)

In every interaction world, there is a continuity of ongoing weaving of a complex web of meanings in which we live, constructed by the interactions that take place in that world.s In that web of meanings, gender is a web of meanings on women and men, masculinity and femininity, which is connected to other webs of dualistic meanings. Gender is a process[1] in which the meaning of masculinity and femininity are mutually constructed, situated at symbolic, individual and institutional levels of a domain. All social activities, practices, and structures are influenced by gender. The meaning of gender is thus embedded in social and cultural constructions and is always dynamically linked to the meaning of many concepts, such as technology or the relation between use and design. The performances of gender are the symbols for power relations in a domain (Harding, 1986; Scott, 1988).

RE-GENDERING THE INFORMATICS DOMAIN

Gender is covered by the unquestioned habits of the domain and discipline of informatics. The performance of gender can become visible through questioning and doubting: What has been overvalued, what has been undervalued and what has been ignored? The deconstruction[2] of the opposition "use-design" will function as a source for doubts on the discourse and the acting, methods and theories in the informatics discipline and the application of information and communication technologies (ICTs) in the informatics domain. Analyzing these kinds of power oppositions, such as use-design, could prevent the risk of reducing masculinity and femininity to fixed attributes based on biology and sex. The hierarchical opposition "use-design" is linked to other oppositions, such as "technical-human," "hard-soft" and "secure-doubtful." These gendered symbolic links are established and reinforced through the military, mathematical and technological traditions of the informatics discipline and through concepts of female informatics based on essentialist and deterministic views on femininity and technology. Strategies to destabilize this matrix of links are not easily found and executed for female ICT professionals. To accept the established horizon of the informatics discipline means to lose the potential of doubt, because socialization demands a commitment to the practices of the discipline. To oppose could be interpreted as a reinforcement of the link between the technical-social and male-female oppositions.

Use and Design of ICT Representations

Deconstruction of the opposition "use-design" in the informatics domain reveals that use and design are treated as activities in different worlds—the world of senders and the world of receivers—while ICT products are seen as the exclusive links between these worlds. ICT representations are perceived as the products of a design process if the product is new and innovative in the receiver world whether that the process of making was only a process of applying obvious methods and routines of the informatics discipline.

The symbolic meaning of use and design is constructed as an opposition in which "design" is active and virtuous and "use" is passive and uncreative. Designers see themselves and are seen as makers of a better future and working in a straightforward line of progress. Designers follow the ideal of making ICT products that cause no disturbances and fit completely within the assumed expectations of the users. The concept of "user friendliness" is based on this notion of non-problematic interaction, doubtlessness and reliability of interaction. "Good" design is defined as making a product for users that should not create disharmony or doubt in the life of the users. Easiness is equal to progress and "user friendliness" (Markussen, 1995).

There is a dominant belief in the objectivity of values: a belief that qualities as "good," "innovative," "friendly," "secure," and "reliable" can be measured objectively and that their achievement can be planned in advance before sending the product into the users' world. The design of ICT products is characterized as decision making, problem solving, optimizing, controlling, prescribing and predicting, and therefore has become an activity of displaying power. Design is focused on generalized and classified users. Users are turned into resources, which can be used by designers in the process of making ICT products.[3] The announcement of new products often is performed like a religious proclamation. The use of expert languages and methods within the closed-interaction world of informatics also establishes the dominance of design over use.

Cause, Doubt, and Change

One of the main causes of the hierarchical opposition between use and design is that oversimplified models for interaction and communication are used in the informatics domain. For instance, "use-cases" in UML are presented in simple action-reaction diagrams. In models such as the transmission model and the impulse-response-model, there is no room for processes of meaning construction. "Communication" is defined as the transmission of representations from a sender to a receiver through a neutral channel. Transmissive models of communication do not have "a message to the message." The meanings of a message, the role of sender and receiver, are fixed and separated. The sender has the active role and the receiver has the passive role.

The channel of communication is conceived as neutral. It cannot influence the interaction of sender and receiver. There is no room in the models for negotiation or doubt. Interaction and communication are only defined on a technical and syntactical level but then are used on semantic and pragmatic levels to construct planned and closed interaction. The semantic and pragmatic ambiguities that occur in "being in interaction" are ignored. Ambiguity is seen as troublesome and inconvenient and, thus, has to be prevented and "dissolved" at the technical and syntactical level (Crutzen, 1997, 2000).

Those models of interaction are frozen into the behavior of computer scientists and into the ICT representations they themselves use and apply and force back onto the informatics domain by ICT products ready-made for users. Design in informatics is seen as making a product for a remote world, whose interaction can be modeled from a distance and without being experienced. In the process of making ICT representations, professionals are mostly not designing but using established methods and theories. They focus on security and non-ambiguity, and are afraid of the complex and the unpredictable. Meaning construction processes have disappeared in processes of doubtless syntactical translation.

Users are not given enough opportunities to intertwine use and design. They are not subjects, but mere objects in the ICT representations.

FUTURE TRENDS

Transformative Critical Rooms

The creation of transformative critical rooms is necessary for making the gendering of the informatics domain visible and present. Interdisciplinary interaction and deconstruction are helpful strategies to search for places of interaction where transformative critical rooms can be created in a discipline. By deconstructing the "use-design" opposition in the informatics discipline and domain, the vanishing of the critical "subject-position" and the vanishing of design as a changing activity focused on an openness of the future can be "disclosed." Changing the frozen habits can start with the disclosure and the repair of a variation of "transformative critical rooms" that were closed in the past. These "rooms" should be reopened and redecorated with differences. However, that redecoration is only possible in interdisciplinary fashion.

Creating "transformative critical rooms" needs actors who have a habit of causing doubt. The discourse in Gender Studies on "subject-object" relations, "subjectivity-objectivity" and possible constructions of truth and reality in three main feminist tendencies toward generating new theories of knowledge—feminist empiricism, feminist standpoint theory, and feminist postmodernism—are developed out of critical positions in and towards these three tendencies. They have in common that they reject the claim of universal truths; truths are always particular and situated. Actors socialized in gender studies can cause doubt in the informatics discipline by presenting their critical way of acting and exploiting the play of differences.[4]

The Interaction Between Human Actors and ICT Representations

One transformative critical room, where redecoration is urgent, is that of the interaction between human actors and ICT representations. Much of people's life consists of interaction with themselves and interaction with others: people, machines, animals, objects and so forth. In the future, people will live in ICT-based webs of connections, in ICT-based webs of interaction systems. Webs will be in the people, and at the same time, people will be nodes in several webs of interaction. They will become "Cyborgs" and live in "cyborg worlds" (Haraway, 1991). So, a lot of interaction will be influenced by ICT. This influence should not be a deterministic one, because people themselves should construct the meaning of the technology. In the view of Heidegger, the essence of technology is "*disclosing something, for bringing it forth, for letting it be seen*" (Zimmerman, 1990, p. 229).[5] It is the opening of "Dasein" itself, even to the discovery that human actors will become "*standing reserve within the global technical system*" (Heidegger, 1962, pp. 21-28; 1936, pp. 39, 41; Zimmerman, 1990, pp. 215, 229).

Redecoration means to reconstruct the meaning of "use": Using ICT representations means always designing and redesigning a flexible world of interactions between human and non-human actors in which the connections can always be disconnected by the actors involved. Doubting the obvious use of ICT representations can uncover this projective acting into the future. "Being-in-interaction" means that the activities of use and design are always intertwined in a process of learning. In this view, designing can be conceptualized as changing and changed acting as a projection to future acting.

CONCLUSION

The dichotomy between design and use has no traditional gender roots. This dichotomy is present in the discipline and the domain of informatics. It is only in a continuous repeated meaning construction process in our culture that this dichotomy is linked to masculinity and femininity, in which people have established the meanings that design activities are more consistent with masculinity, while use is more consistent with femininity. It is unjustly to repeat the questions "Are males better qualified to tackle design tasks, while females are better equipped to understand "use"? Question gender means a redecoration of the empty rooms between the binary oppositions use and design. These rooms cannot be found at the border of the informatics discipline but only within the discipline itself. Through creating transformative critical rooms, which are leavable, women can cultivate an erotic relation to ICT representations, feeling attraction and antipathy simultaneously. In these rooms, it can be proved that simple communication models are not sufficient enough to represent the way people are interacting. In this redecoration process, the meaning of use and design will change and it will be seen as intertwining activities. The empty room between use and design will be filled with many different meanings on use and design and can lead to a more critical use of methods and theories in informatics.[6]

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KEY TERMS

Change: Every interpretation and (re-)presentation will influence future action. Acting is a representation of the interpretation of the phenomenal features of the world. It includes the interpretation of the results of our action. Not only the actual behavior but also the actions, which are not executed in the interaction (actions in deficient mode), are presentable and interpretable because these absent actions influence the ongoing interpretation and representation processes. Every action and interaction causes changes. However, if changes caused by interaction are comparable and compatible with previous changes, then they will be perceived as obvious. They are taken for granted.

Deconstruction of Gender: Deconstruction is a method to evaluate and analyze implicit and explicit aspects of binary gendered oppositions, such as "use-design." The meaning of the terms of oppositions, constructed as a weave of differences and distances, can be traced throughout the discourse of a discipline and its domain. By examining the seams, gaps and contradictions, it is possible to disclose the hidden meaning on gender and the gendered agenda. Identifying the positive valued term, reversing and displacing the dependent term from its negative position will reveal the gendering of the opposition and create a dialog between the terms in which the differences within the term and the differences between the terms are valued. It uncovers the obvious acting in the past and how it has been established.

Informatics Domain: The informatics domain is a world of actors in which ICT representations are designed and used, presented and interpreted. ICT representations are present in this world not only as hardware and software. Methods and theories used for designing and making ICT products are representations within this world. The informatics discipline is a part of and an actor in this world of interactions.

Interaction: The concept "interaction" is seen as an exchange of representations between actors. All acting of an actor is a representation of the actor and, through acting, the world of the actor changes. This exchange of representations is not a simple transmission process from sender to receiver. Interaction is a process of constructing meaning through repeated interpretation and representation, which is always situated in the interaction itself and depends on the horizons and the backgrounds of the actors and representations involved. Heidegger calls this mutual action projected in the future Sorge (care), Fürsorge (solicitude) and Besorgen (concern) (Heidegger 1926, §12,15, 26; Figal 2000, pp. 81, 144; Inwood, 1999, pp. 35-37; Mallery, 1994).

Interaction World: An interaction world is constructed by the interactions that take place in that world by human, non-human and artificial actors. It is a process of constructing meaning through repeated interpretation and representation of actors. It develops by and stabilizes through the continuity of ongoing weaving of a complex web of meanings in which humans live. Being in an interaction world is being with others, sharing each others' meaning through acting. Interaction is an ongoing process of mutual actions from several actors in a (series of) situation(s).

Transformative Critical Rooms: A "transformative critical room" is a place of negotiation between interpretation and representation. In rooms in which differences can be present, truth can be seen as an ongoing conversation and a process of disclosure, and not as correspondence to reality. Truth is, then, merely a construction of actors in interaction. In transformative critical rooms, actions that cause doubt are seen as fruitful. In such rooms, doubts on representations are possible and can be effective in a change of the acting itself and in a change of the results of this acting: the interpretations and representations. The "preferred reading" of representations can be negotiated. There is space between interpretation and representation. Differences and different meaning construction processes are respected. The act of doubting is a bridge between obvious acting and a possible change of habitual acting. Doubt is always situated in the interaction itself. Doubt cannot only occur by the visible in the interaction but also by the invisible. Doubt is a meaning given to a situation in the interaction, which could lead to the change of meaning, to changed acting and, in the end, to a change of the established routines in an interaction world. Actors and representations are present in an interaction world that functions as a critical transformative if they are willing or have a potential of creating doubt and if they can create disrupting moments in the interaction.

Unified Modeling Language (UML): UML is a general-purpose notational language for specifying and visualizing complex software, especially large, object-oriented projects. UML is also used as a standard notation for the modeling of real-world objects as a first step in developing an object-oriented design methodology. Its notation is derived from and unifies the notations of three object-oriented design and analysis methodologies:

- Grady Brooch's methodology for describing a set of objects and their relationships
- James Rumbaugh's Object-Modeling Technique (OMT)
- Invar Jacobson's approach that includes a use case methodology.

Use-Case: A use case is a methodology used in system analysis to identify, clarify and organize system requirements. The use-case is made up of a set of possible sequences of interactions between systems and users in a particular environment and related to a particular goal. A use-case is a collection of possible scenarios related to a particular goal.

A use-case (or set of use cases) has these characteristics:

- Organizes functional requirements
- Models the goals of system/actor (user) interactions
- Records paths (called *scenarios*) from trigger events to goals
- Describes one main flow of events
- Is multi-level, so that one use-case can use the functionality of another one.

Use cases are employed during several stages of software development, such as planning system requirements, validating design, testing software and creating an outline for online help and user manuals.

ENDNOTES

1. Judith Butler sees gender as a daily performance of each individual: "… rather, gender is an identity tenuously constituted in time, instituted in exterior space through a stylized repetition of acts." (Butler, 1990, pp.140)
2. On deconstruction, see Brunick, 1995-1996, II. D. Deconstruction; Meijer, 1991; Culler, 1983, p.155, pp. 213-215, p.228; Faulconer, 1998; Biesta, 1998; Crutzen, 2000.

Q

3 Steve Woolgar tells us about the opinion on users of a company that develops a PC: "The user's character, capacity and possible future actions are structured and defined in relation to the machine. ... This never guarantees that some users will not find unexpected and uninvited uses for the machine. But such behavior will be categorized as bizarre, foreign, perhaps typical of mere users." (Woolgar, 1991, pp. 89)

4 See Adam (1998); Suchman (1994a, 1994b).

5 Heidegger expresses the essence of modern technology as a challenging-forth or challenging-revealing. "This challenging sets upon what is, nature, the genetic profile of the individual human being, the graphic imagination of the human relationship to the cybernetic domain, and so on and reveals it on the terms of that same technical challenge or set up" (Babich, 1999). According to Babich, Heidegger's questioning of technology reveals that questioning is more than a "calculative convention (namely that of question and answer)." It is "an open-ended or attentive project."

6 See Crutzen and Kotkamp (2006).

Questioning Gender through Transformative Critical Rooms

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INTRODUCTION

Using the discourse of Gender Studies (Harding, 1986), proves to be a fruitful strategy to question methods, theories and practices of the Informatics discipline (Suchman, 1994a, 1994b). It shows the problematic notion of the binary opposition of use-design and it uncovers the objectification of both users and designers in ICT-representations in the designing process (Crutzen, 1997, 2000a, 2000b).

To further this analysis of the informatics discipline the concept of the transformative critical room is a very important one. A transformative critical room creates space where the interpretation of ICT-representations can be negotiated and where doubt can occur as a constructive strategy. Creating these rooms require actors who already have a habit of causing doubt and who accept that truths are always situated. Within gender studies these concepts of situated knowledge's and the critical assessment of subject-object relations are at the core of many feminist theories (Crutzen, 2003; Crutzen & Kotkamp, 2006).

A transformative critical room where a feminist analysis is of great importance is the room where interactions take place between human actors and ICT-representations. In this interaction, the meaning of "use" needs to be reconstructed. Using ICT representations imply the (re)design of a flexible environment where the connection between human and non-human actors can always be disconnected. When introducing this possible disruption in these ICT-representations it shows that the activities of use and design occur simultaneously with a process of learning. This means that designing is always an ongoing process where change takes place and where actability becomes an important condition.

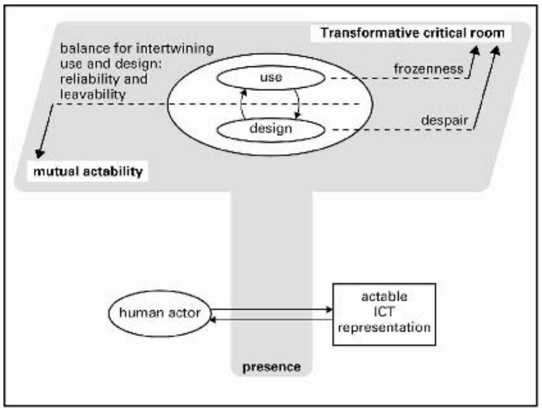
MAIN THRUST

Disclosing ICT-Representations

Open ICT-representations are "mutual actable" for an actor. Actability is not a condition of the ICT-presentation. Mutual actability is the process in which the intertwining process of use and design can be based on doubting the obvious way of interacting and the ready-to-hand routines of the ICT-representation. Mutual actability is a process between an actor and a representation and depends on the presence of an ICT-representation for an actor. The process of intertwining design and use is always individual and situated in the interaction. It depends on the affective disposition and the state of mind of the actor.

Therefore, the intertwining of use and design needs the presence-at-hand of the ICT representations. Their readiness-to-hand should not be fixed. ICT-representations are present in a world of actors if they cause doubts and if the representation is at the

Figure 1. The intertwining of use and design



same time "leavable" and reliable. The doubt in acting should be possible but should not lead to desperation or to a forced routine acting. Despair caused by the ready-made acting of the ICT-representations, which allows only acting in a pre-given closed way or by their breakdowns, which leads to doubting your own acting and not the ready-made acting of the ICT-product. ICT-representations have a presence of leavability if representations allow the user to use the ICT-representations as a routine but also give the users the opportunity of learning in which situations the ICT-representations are adequate and in which situations they should be abandoned.[1]

The acting and interacting of people will be influenced by the acting of the ICT-representations that are made ready. Processes of negotiation and construction are necessary not only with the contents of the representations but also with the behavior and memory of ICT-representations to make the range between desperation and obvious acting leavable, useful, and reliable. Translations and replacements of ICT-representations must not fit smoothly without conflict into the world they are made ready for. A closed readiness is an ideal, which is not feasible because in the interaction situation the acting itself is ad-hoc and, therefore unpredictable. The ready-made behavior and the content of ICT-representations should be differentiated and changeable to enable users to make ICT-representations ready and reliable for their own situated use.

FUTURE TRENDS

The Method OO as a Transformative Critical Room

The object-oriented approach (OO)[2] is used in the Informatics discipline as a method for interpretation and representation, for analyzing worlds of interaction, representing design models, and producing hardware and software systems. OO as it is used for the representation of the dynamics of interaction worlds leads us beyond the data-oriented approach and makes room for the opportunity to discuss the character of human behavior. Knowing that the essence of human behavior is not predictable and is situated in the interaction itself we can discover that OO will only disclose planned action. With abstraction tools in OO such as classification, separation, and inheritance, they colonized real world analysis processes.

This colonization from ICT-system realization into world analysis is dictated by the analyzing subjects' focus of avoiding complexity and ambiguity by selecting the most formalized documents, texts, tables, schemes in the domain which are close to the syntactical level of object oriented programming languages and by transforming natural language into a set of elementary propositions. This results in hierarchical structures and planned behavior to be enlightened, and in ad hoc actions and interactions to be darkened.

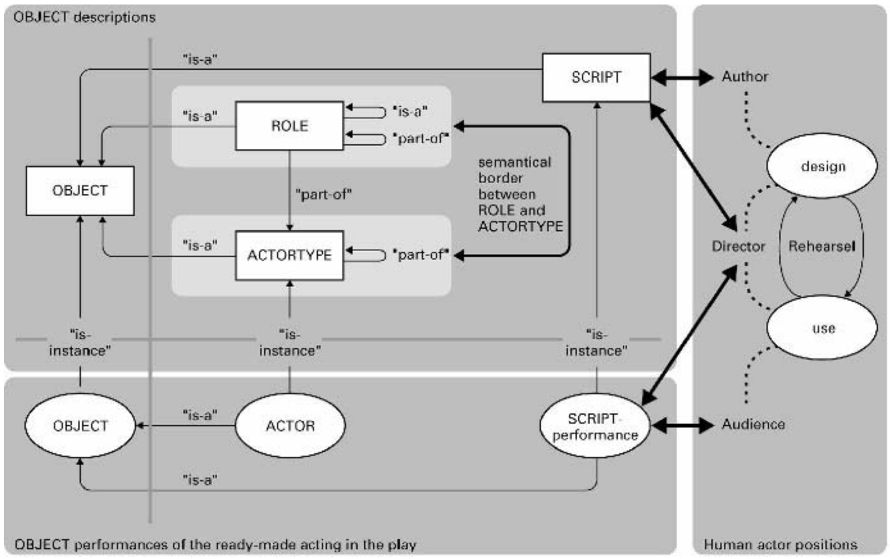
This use of OO in Informatics is exemplary for the ontological and epistemological assumptions in the discipline: not only is it possible to "handle the facts" but also to handle and therefore control real behavior itself. The expert users of the object-oriented approach suggest very heavily that OO can objectively represent the total dynamics of reality with its method to create OBJECTs: artificial representations.

Feminist theories can give arguments for doubting the assumptions within the OO approach because these approaches are always based on the same illusions of objectivity and neutrality of representation, the negation of power and dominance by its translation into something "natural and obvious." Leaving OO means to use it only for the purpose it was originally meant for: the production of software. OO-based software, which consists in predictable and planned interaction, cannot be the fundament for the representation of humans.

However, a total rejection of OO cannot be the answer to the doubts. The presence of OO-based products enforces the disclosure of some unwanted consequences of OO. In OO, ambiguity and doubt are hidden, but they are not absent. As a starting point for the use OO-based systems, a comparison with the theatre metaphor is useful for changing the position of the user (see Figure 2).

The OBJECT[3] is the basic unit in an OBJECT world description: the SCRIPT for an "interaction play" of cooperating OBJECTs. In the position of Audience or ACTOR (the intended roles of the user)

Figure 2. OO as theatre



humans can enjoy the OBJECTs playing in the OO world. The OBJECT's ready made acting can be a useful tool integrated in the activities of our daily life. In this aspect the performance of an OBJECT play should be reliable. However if we are, as users, just ACTORs in an OO play, then we are determined to play as OBJECTs, with no doubt, and follow the prescriptions of the pregiven SCRIPT without thinking. Functioning as an OBJECT, we cannot escape the life cycle of states and transition rules of the ACTORTYPE "user" that is embedded in the script. Intertwining use and design activities is possible if we could change our position of only being a passive "Audience" member or a forced ACTOR to the position of being the "Director" or "Author" of the play. Humans should have the possibility to rehearse and to experiment with ROLE's and to test differentiated and situated leavability of the OO-software. As a "Director" or "Author", we could create out of ROLEs new ACTORTYPEs or aggregate old ones to a new surprising play. We could solve the conflicts within the aggregated ACTORTYPE so that they can cooperate in a way that is suited for special situations and act in a way that gives priority to our purposes, even if this could make our self-created ACTORs unpredictable or unreliable. As humans, we like to create new interaction worlds out of the present-at-hand ROLEs. Moreover, plays of which we do not know the plot we enjoy the most. Open and connectable OBJECTs can give us the opportunity to edit the OO play and to replace parts with our own (inter)actions. And that is precisely the essence of their attraction. OBJECTs are aggregated ROLEs in a play or are things to use and integrate in acting. Humans are Authors and Directors creating the play; rewriting the ontology of the OO-approach to make it possible to look at OO realizations as plays of artificial ACTORs directed by users.

Free/Libre Open Source Software as Open ICT-Representation or Transformative Critical Room

An example of a transformative critical room is Free/Libre Open Source Software (F/LOSS). Software under an open source licensing form destabilizes the power relation at work when designing an ICT product. It deconstructs the before mentioned dominant believe of objectively measurable user friendliness, reliability etc. that can be planned in advanced. By merely providing the opportunity to adapt, the product in its base level of source code after distributing the software it again acknowledges different interpretations of use/design. This renders it impossible to hold on to a belief in objective measuring.

The available source code itself is a representation of the designer and the designer creates the opportunity of doubt to the expert user. In the case of OO-software it comes close to the possibility of (the almost literally) rewriting the ontological assumptions of the OO approach. By providing (expert) users access to and insight into the source code it opens up a space to negotiate the different performances involved. It gives the expert user the opportunity to create and or alter the artificial representation (OBJECT) as well as direct the aggregated ROLEs of the OBJECTs. Expert users are given the position of an author, because they can rewrite the software script.

By creating this opening, the objectivity of the representation is automatically questioned since the starting point of the creation of OBJECT, ACTORTYPE, ROLE, and SCRIPT is keeping it visible to the different human actor positions. In doing so, it shows the necessity of acknowledging the need and possibilities for different representations. F/LOSS does not set out to represent humans and all human interactions. The underlying assumption is that ambiguity and doubt is not only present but facilitates different ways of dealing with it by different actor positions. Furthermore, F/LOSS offers the most effective way of using OO: by being open source it provides the opportunity to combine models and reuse class definitions from other ICT products that might not seem to be an effective combination for one user/designer but might for another. In providing this, it encourages discovery and creativity by both designer/users and prevents user/designer/OBJECT to turn into pre-defined resources. By preventing this user-designer, OBJECT cannot fit into a pregiven class since the pregiven class is changeable and adaptable.

For the non-expert user F/LOSS creates the possibility to choose between the different available software. For the non-expert user it can create a position of a director since the software producer cannot determine anymore the mutual actability of software. Furthermore, in using open source software, users have more opportunities for direct contact to designers and expert-users, to discuss changed performances of the open source software.[4]

Overall, the concept of F/LOSS products is an example of a critical room within the domain Informatics. Apart from being a strategy to challenge the ontological assumptions of OO, F/LOSS development also provides an opportunity to challenge the much-used dichotomy between user and designer. Just as feminist theories are a theoretical strategy to deconstruct the binary opposition of user-designer; open source software provides a practical strategy to deconstruct this binary opposition. By literally making it possible for the user to become a designer and for the designer to be a critical user of its own product, it shows the impossibility of maintaining this opposition.

CONCLUSION

To ignore ICT-products is impossible. Therefore, one should be pragmatic and live between the borders of the binary oppositions and assess the construction of subject-object relations.

By creating leavable transformative critical rooms, a feminist approach can blow up the separation of use and design, and intertwine use and design through doubting the ready-made interactions. Through the creation of an opening and a redecoration in this cleared room between use and design, processes of intertwining use and design, and of changing interactions and representations can be started.

Transformative critical rooms are the necessary condition for making visible the gendering of the Informatics domain and for presenting and allowing a mutual dialogue between the female and the male in which differences can continue to exist. This answer is not a closed solution. It is the designing behavior of women and men, which can vivify the differences in future worlds of interactions.

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KEY TERMS

Actability: Human actors can experience other actors as "actable" if these actors present themselves in a way, which is interpretable out of their own experiences. That does not mean that this is the intended interpretation because each actor has her or his horizon of experiences and expectations. Tools and things are actable, if humans can give meaning to them by drawing them into their interactions. A necessary condition of actability of artificial tools is that humans can perceive the performance of the non-human actor.

Free/Libre Open Source Software: Also referred to as open source software or free software. F/LOSS is a licensing type of software that has 4 main characteristics as defined by the Free Software Foundation:

- The freedom to run the program, for any purpose (freedom 0).
- The freedom to study how the program works, and adapt it to your needs (freedom 1).

Access to the source code is a precondition for this.

- The freedom to redistribute copies so you can help your neighbor (freedom 2).
- The freedom to improve the program, and release your improvements to the public, so that the whole community benefits (freedom 3). Access to the source code is a precondition for this.

The free in F/LOSS is not be confused with the price of the software but refers to the freedom as in freedom of speech. This is the reason the Libre is added; to clarify this. There are many different types of licensing that have variations on the 4 characteristics; one of the most important ones is the GNU General Public License (GNU-GPL) that was instated by Richard Stallman, who is with Thorvald Linus, the most important developer of the GNU/Linux operating system. There is much debate over advantages and disadvantages of open source software from different angles ranging from economical arguments to technical arguments to academic to socio-political arguments. See for more information

How open is the future. Economic, Social and Cultural Scenarios inspired by Free and Open Source Software" edited by Marleen Wynants and Jan Cornelis, published in 2005 and downloadable here: http://crosstalks.vub.ac.be/documents/howopenisthefuture_CROSSTALKSBOOK1.pdf (last checked February 18th, 2005)

Mutual Actability: Mutual actability is a process of interactions that creates a transformative critical room between actors. Mutual actability of a tool and user can develop if the actor can intertwine use and design activities. The borders of the transformative critical room are on the one side, the frozenness of use and on the other side, the despair of a continuous forced design, for instance the tool causes doubt continuously by mal functioning.

Object-Oriented Programming: Object-oriented programming (OOP) is a programming language model organized around "objects." Objects are the things you think about first in designing a program and they are also the units of code that are derived from the design process. Each object is made into a generic class of object and even more generic classes are defined so that objects can share models and reuse the class definitions in their code. Each object is an instance of a particular class or subclass with the class's own methods or procedures and data variables. An object is what actually runs in the computer. Examples of objects range from human beings (described by name, address, and so forth) to buildings and floors (whose properties can be described and managed) down to the little widgets on your computer desktop (such as buttons and scroll bars).

ENDNOTES

1. Heidegger calls this "Verläßlichkeit". He used it in two meanings: leavable and trustworthy (reliable) (1936, pp. 28-29)
2. For the construction of such transformative critical rooms on OO in Education see: Crutzen 2000a, Crutzen 2000b, pp. 368-391. For the OO approach see: Booch 1994, Jacobson 1992, Rumbaugh 1991
3. With the word "OBJECT" in uppercase is meant a constructed artificial entity within the ontology of the object-oriented approach. The word "object" in lowercase is an entity in reality, which can be observed and represented by a subject.
4. Even though access to these resources and knowledge are determined by in- and exclusion mechanisms that can be shown through a gender analysis of these processes.

Race and Gender in Culturally Situated Design Tools

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INTRODUCTION

In theer study of equity issues in information technology (IT), researchers concerned with workforce diversity often utilize the metaphor of a "career pipeline." In this metaphor a population full of gender and race diversity enters the pipeline in kindergarten, but its delivery at the pipeline outflow in the form of software engineers and other IT workers is disproportionately white and male. While we might question the metaphor—its lack of attention to economic class or social construction, its illusion of rigid boundaries, etc.—the phenomenon it describes is well established by a broad number of statistical measures. For example, the U.S. Bureau of Labor Statistics' Current Population Surveys shows that between 1996 and 2002 the percentage of women in the overall IT workforce fell from 41% to 34.9%; during the same period the percentage of African Americans fell from 9.1% to 8.2%. Not only are women and certain minority groups under-represented, but the gap is in some cases getting worse. Returning to the pipeline, we might ask what barriers are encountered by women and minorities that act as impediments to this flow. Some of these barriers can be attributed to economic status; in particular the impact that poor educational resources have on low-income minority student academic success (Payne & Biddle, 1999). But other barriers appear to be more about cultural identity, including both race and gender identity. This essay describes Culturally Situated Design Tools (CSDTs), a suite of Web-based interactive applets that allow students and teachers to explore mathematics through the simulation of cultural artifacts, including Native American beadwork, African American cornrows, ancient Mayan temples, urban Graffiti, and Latin percussion rhythms (see http://www.rpi.edu/~eglash/csdt.html). Our preliminary evaluation indicates that some of the identity barriers preventing women and minorities from participating in IT careers can be mitigated by the use CSDTs in classroom and out of class learning environments.

BACKGROUND

Cultural Identity Conflict in Science and Technology Curricula

While many problems in minority student performance can be directly attributed to economic circumstances, other barriers are more cultural. Fordham (1991) and Ogbu (1998) document the ways in which African American students perceive a forced choice between Black identity and high scholastic achievement (e.g., the accusation that they are "acting white," which Fordham connects to "peer-proofing"). Although some researchers (Ainsworth-Darnell & Downey, 1998) have critiqued this framework for its conflict with the positive view of education reported on minority attitude surveys, Mickelson (2003) has shown that there is a difference between what she terms "abstract" conceptions of education, which all racial groups respond to positively, and "concrete" conceptions of education which differ across racial groups and correlate with disparity in academic achievement. Martin (2000) reports a similar finding in African American conceptions of "cultural ownership" of mathematics. Powell (1990) found that pervasive mainstream stereotypes of scientists and mathematicians conflict with African-American cultural orientation. Eglash (2002a) describes conflicts in the identity of the "black nerd" in both popular imagination and reality. Similar assessment of cultural identity conflict in education has been reported for Native American students (Moore, 1994), Latino students (Lockwood & Secada, 1999), and Pacific Islander students (Kawakami, 1995). In addition to peer-proofing and identity conflict, the recent NSF-sponsored study of how minority students are lost in the science and technology career "pipeline" (Downey & Lucena, 1997) is also consistent with these results: many minority students with good math aptitude reported that they dropped out because they did not see how science or technology could have the connections to their cultural background offered by arts, humanities and social studies. Thus, perceived social irrelevance is a third obstacle to minority flow through the pipeline.

Mathematics is a key gate-keeper to the science and technology career pipeline, and the above cultural barriers—peer-proofing, identity conflict, and social irrelevance—can all be observed in minority barriers to mathematics achievement (Martin, 2000; Moore, 1994). In addition to these conflicts between cultural identity and mathematics education, another component for the poor mathematics performance in these minority groups is suggested by the work of Geary (1994). His review of cross cultural studies indicates that while children, teachers, and parents in China and Japan tend to view difficulty with mathematics as a problem of time and effort, their American counterparts attribute differences in mathematics performance to innate ability. This myth of genetic determinism then becomes a self fulfilling prophecy, lowering expectations and excusing poor performance.

Similar barriers are found for gender. Stipek and Heidi (1991) for example found that girls in their study expressed a persistent belief that they lacked an innate math ability. Tiedemann (2000) found that teachers in his study tended to attribute poor performance in girls to genetic causes, and poor performance in boys to lack of effort. The recent controversy over comments by the president of Harvard University proclaiming his belief that the under-representation of women in the sciences could be attributed to biological differences shows that this mythology persists at the highest levels of education. In addition to biological determinism, the kinds of cultural determinism that minority students must resist—peer-proofing, identity conflict, and social relevance—also operate as barriers to girls. For example, Armstrong (1979) found that sexist stereotypes of parents, peers, and teachers influenced girls' decisions not to participate in math. The previously cited study of Downey and Lucena (1997) showed that some female students, like minority male students, also reported that they dropped out because they did not see how science and technology could give them the focus on beneficial social change offered by arts, humanities, and social studies.

Ethnomathematics: An Alternative View of Mathematical Knowledge

Ethnomathematics (Ascher, 1992; D'Ambrosio, 1990) is the study of mathematical practices in various cultures. While many studies have reported on variations in numeration systems (the Mayans used base 20, etc.) ethnomathematics takes a much broader view. It also considers the mathematical practices that are embedded in designs such as architecture, baskets, beadwork, divination, navigation, sculpture, textiles, etc. What distinguishes ethnomath from the broader category of "multicultural mathematics" is that ethnomathematicians strive to *translate* between indigenous concepts and the corresponding representations in standard (Western) mathematics. In my own work (Eglash, 1999) for example, interviews with traditional African artisans showed that they used specific geometric algorithms to construct recursive scaling structures (fractals). Other researchers have applied the same translation process to vernacular knowledge rather than indigenous knowledge. Lave (1998) for example considers the algebraic properties of knitting, which is generally more identified by gender than race. Other examples of gender-based ethnomathematics analyses can be found in Gilmer 1998.

Cultures characterized as "primitive" by colonialists can be shown to utilize sophisticated mathematical ideas, and vernacular knowledge that was dismissed by sexist stereotypes as trivial "women's work" can be appreciated in a new light. Thus ethnomathematics analyses are useful in opposing harmful myths of cultural and biological determinism in both race and gender.

Given the race and gender barriers to math achievement in pre-college education, it might seem like an obvious step to move from this academic research on ethnomathematics to direct application of ethnomathematics in the K-12 classroom. But this is more difficult than it sounds. First, many of these mathematical topics, such as fractals, are not part of the standard K-12 math curriculum. Second, many children are unaware of their own heritage culture, or uninterested in traditional activities. For these two reasons we have developed a suite of Web-based applets called “Culturally Situated Design Tools.” Each design tool allows students to simulate a cultural practice such as Native American beadwork, African sculpture, etc. Their grade levels range from 4 to 12. Each site includes a cultural background section, a tutorial, the software itself, and a “teaching materials” section of lesson plans, evaluation instruments, samples of student work, and other support. The design tools can be integrated into standards-based curricula, including a variety of specific math topics as well as state and national standards for more general areas such as technology use and understanding patterns. At the same time, this expressive computational medium affords new opportunities for researchers to explore the relationships between youth identity and culture, including that of gender identity.

MAIN THRUST OF ARTICLE

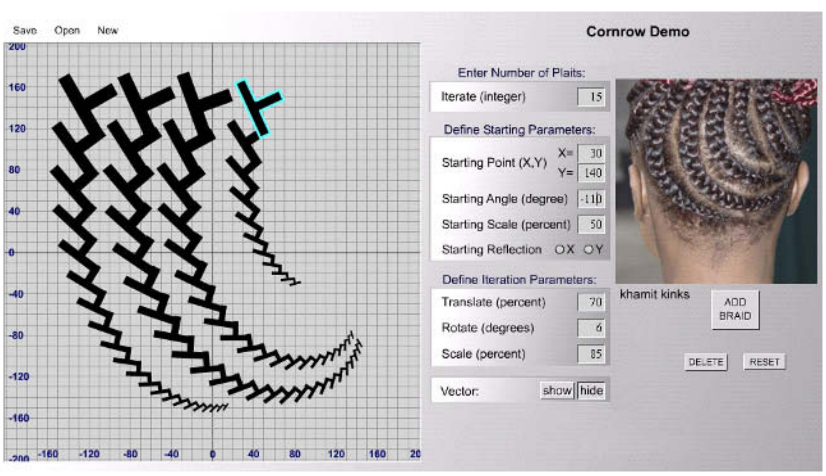
From Ethnomathematics to CSDTs: Examples from Cornrow Curves

Our first software application began with the “African Fractals” material, using graphical simulations of recursive scaling patterns in architecture, textiles, sculpture, etc. Discussions with teachers from inner city areas in which there were large numbers of African American students lead to the following three critiques: First, they mentioned that fractal geometry is not part of the K-12 standard curriculum. Second, they noted that the computer design was primarily carried out with mouse movements, not numeric or symbolic inputs. Finally, they noted that not only were their students doing poorly in math, but that they also knew little about Africa.

The cultural challenge of making the connection with African American students who had little knowledge of Africa was solved by three innovations. First, following teachers suggestions, we focused on the example of fractal patterns in cornrow hairstyles, and titled the software “Cornrow Curves” (Figure 1).

Typically each criss-cross (“plait”) of the hair diminishes in size, creating several iterations of scale in a single braid; to that extent it matches the other African traditions of recursive scaling. But cornrows are part of the African mathematical heritage that not only made it through the middle passage, but are still an on-going area of innovation in contemporary culture. Because many students we spoke to were unaware of this legacy (“Cornrows were invented in the 1970s” was a common statement, we developed an historical background page for cornrows, which included images and information covering the indigenous

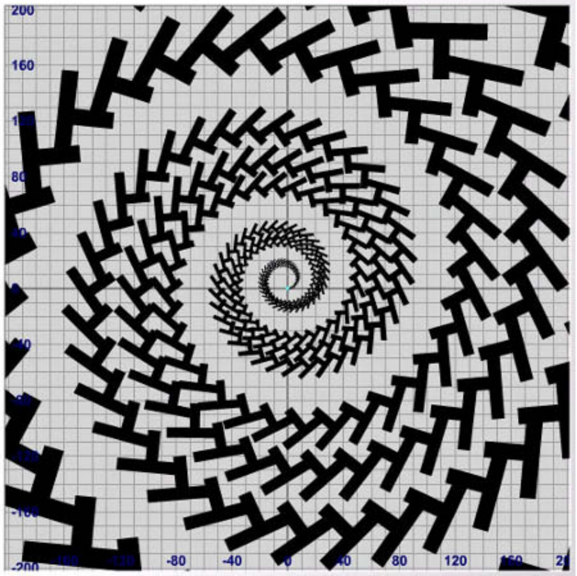
Figure 1. Cornrow curves



styles and meaning in Africa, their appearance in the pre-civil war era, and their new significance in post-civil rights and hip-hop cultures.) Finally, we also created a series of "goal images": photos of styles for students to simulate, including both professional styles and photos the students took of themselves and their friends. This allowed students to make the connection from contemporary vernacular identity to heritage identity, which then opened up a wide selection of indigenous African fractal patterns.

It was a simple matter to replace the mouse-driven interface with numeric input, as can be seen in Figure 1. Separating these parameters numerically also addressed the problem of fitting fractal geometry into the curriculum: now it was about geometric transformations, not fractals, and transformational geometry is a component of the state and national standards. In addition to several years of software development and cultural studies (ranging from history of black culture to interviews with stylists) the following discussion makes use fieldwork carried out from 2001-2004 in summer and after-school workshops in Albany, NY, and Troy, NY, with students ranging from middle school to high school. The classes ranged from all-minority to majority white. Most minorities were African American and Puerto Rican (which included students with African heritage).

Figure 2. "tis-abay"



We found that students quickly became adapt at using the software to not only create simulations of the hairstyles, but also generate patterns of their own choosing. Figure 2, for example, shows a pattern one girl named after a waterfall in Ethiopia (her father's place of birth), "tis-abay."

Another advantage of choosing cornrow patterns was that both genders typically found it to be readily accessible. During discussions girls were just as engaged as boys, and even went so far as to suggest that African American males had "stolen" their hairstyle. We found little difference in performance on mathematical, cultural, or aesthetic outcomes across genders, although this was not tracked statistically. Both male and female students generally understood the fundamental ethnomathematics concept—that this was a claim for mathematical knowledge, albeit one that is embedded in a practice rather than represented through symbols. The strongest reaction we heard from any participant was from an African American girl—"I never realized there was math in cornrows!!" The only hesitation in using the software came from two white males; neither had any difficulty once they started working with it. Not large enough for statistical significance, but it does suggest at least a minor role in race and gender interactions in the users' relationship to the software.

For all the design tools, including the Cornrow Curves software, there are three categories of use. First, the software can be used to simulate the original designs. Second, it can be used as an artistic tool in itself. And third, it can be used to conduct mathematical explorations. Some of the mathematical exercises are chosen by teachers. For example, how many plaits does it take to make a braid form a complete circle with no dilation and a 10 degree rotation? The answer is 36, because 36 * 10 = 360. Now try the same with a 7 degree rotation. Now give us a general formula for any degree rotation. Other mathematical exercises are chosen by the students themselves. Several Latino students, for example, have tried to produce an image of the Puerto Rican flag in the virtual bead loom; a task which raises several mathematical challenges (as well as exemplifying the playful hybridity which students enthusiastically bring to these projects).

Other Design Tools

Space does not permit us to describe any other design tools in detail, but we can briefly describe each of them, and make some notes about associated gender issues.

1. The **Native-American** design tools:
   - **The Virtual Bead Loom:** This has been our most popular tool with math teachers. Native students on and off the reservation schools have expressed great enthusiasm for it, but so have white, black, and Latino students. Like Cornrow Curves, it makes use of indigenous practices which are now more female-associated. However, both genders do well with this software. Our graphic designer (co-PI Audrey Bennett) suggests that girls' designs tend to make better use of color. See Eglash, 2002b for more details
   - **Yupik Star Navigation:** Used with 5th grade students in Alaska. The indigenous practice is male-associated, but we did not discern any gender difference. It was interesting to note here the strong interest in cornrows shown by native Yupik girls, but not by Yupik boys, indicating that gender may play a strong role in some cross-cultural experiences
2. The **African**/**African-American** design tools:
   - **Cornrow Curves:** See description in previous section
   - **Mangbetu Design:** This software is very similar to Cornrow Curves, but based on recursive scaling patterns and other geometric symmetries in the artifacts of the Mangbetu society. The artisans themselves tend to be male, but the subject matter was both male and female, and use of the artifacts is by both genders. We obtained similar results to the Cornrow Curves software, with little gender differences observed
3. The **Latino** design tools:
   - **Virtual Temple Builder:** This software allows the users to construct three-dimensional simulations of ancient mayan temples. There was little gender difference observed, although the software is relatively new and we do not have as many samples
   - **Rhythm Wheels:** This software is also relatively new; again we found little gender difference
4. The **Youth Subculture** design tools:
   - **Graffiti Grapher:** We found the reactions to Graffiti Grapher to be profoundly multicultural—for example the two white male students who were hesitant about Cornrow Curves were immediately attracted to it, but so were African American and Latino students. Girls were also interested in it, but seemed less "obsessed." On the other hand, in a recent classroom competition for best Graffiti Grapher design, the winning entry was from a girl. Discussions indicated that girls saw graffiti as a more male-oriented activity.

In summary, the students do seem to have both race and gender associations for the cultural activities that form the basis of CSDTs, but these do not appear to be limiting factors for participation, and in some cases do appear to encourage participation.

Quantitative Results

Our quantitative assessment did not separate results by gender, but both male and female students seemed equally engaged with most activities. Using the Bath County Computer Attitudes Scale we found statistically significant improvement for attitudes toward information technology careers in comparison to a baseline measure in the classes with 90% minority students. There was no significant difference from baseline measures in the sample with majority white students. We did find statistically significant improvement in pre-test/post-test comparisons for mathematics performance for classes of all ethnic compositions, with one exception (where there was a positive increase but small class size prevented statistical significance).

FUTURE TRENDS

We are constantly expanding both the number of design tools, the utility of their interface, and their associated classroom materials, as well as evaluation. We hope to further the qualitative aspects of gender analysis with a more ethnographic approach. One of the most important questions we would like to ask is about the comparison with ostensibly "neutral" software. For minority girls with enthusiasm about engaging software marked as female and non-white, does that contrast with less enthusiastic engagement of software that is marked (and marketed) as neutral? Can this kind of software make visible the currently invisible semiotics of race and gender currently hiding under a mask of generic universalism?

In their excellent anthology on gender in computer games, Cassell and Jenkins (1998) note the wide variety of feminist perspectives. In the question of violence, for example, these range from an "essentialist" positions that would posit an inherent non-violence in female gender constructions, to strongly anti-essentialist positions which applaud girl gamers who can tackle "first person shooter" games and their ilk. In my own experience teaching female engineering students in a design studio, where we read selections from the Cassell and Jenkins volume, I have also found that these women draw their academic and technological strength from a wide variety of positions. For every design studio in which I have seen a cluster of women working together in one group, there has always been one or two others who elbow their way into the most aggressive male group (and often insist on being the one who operates the power tools). It is our hope that the wide variety of experiences offered by the design tools can do justice to this valuable spectrum of gendered identities, and provide the young girls with the positive technological experiences that can bring them through the other side of the IT pipeline.

CONCLUSION

We have seen a broad spectrum of reactions to these design tools in students. While there are some indications that both race and gender associations remain relevant (the enthusiasm of minority girls for the cornrows, the hesitation of the two white males when working with the same, the preference of males for Graffiti Grapher, etc.), what is much more striking is the enthusiasm by students of all ethnic and gender identities for the design tools in general. We believe that one of the reasons for this is the active role that students themselves are able to take in design creation when using these tools. They name their designs after everything from dogs to musicians, and often students have a story to tell with their work.

That is not to say we can overlook the complexity of race and gender identity in our efforts to improve female and minority participation in IT. As Nakano Glenn (1992) argues for the case of service workers, gender and race cannot be reduced to "additive oppressions," and must be seen as the site of an interlocking or relational dynamic. If, for example, a middle school text book says that "women won the right to vote in 1920," is that statement helpful for celebrating a feminist victory, or harmful for ignoring the Jim Crow laws that prevented minority women from voting? There has been a debate in both feminist and anti-racist literature concerning the advantages and disadvantages of tradition. Should women re-evaluate knitting and embrace it as a valued heritage to be recovered, or should they distain its patriarchal roots in sexist division of labor and "busywork"? If we are attempting to respectfully represent traditional cultural practices, should we also represent their gendered divisions of labor?

We posit that the main advantage of the design tools is their ability to facilitate new forms of cultural hybridity, new translations between formally disparate domains (both socially as well as mathematically), and thus new ways of allowing students to create their own identities in relation to science and technology. Expressive media are natural aids to identity formation, and offering students new ways to link identity to math and technology can be empowering across both gender and race.

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KEY TERMS

Acting White: Phenomenon in which minority students perceive a forced choice between "authentic" ethnic identity and high scholastic achievement, largely as the result of peer pressure.

Cultural Hybridity: Mixing of cultures, usually in terms of the identity of an individual who partakes in both "parent" cultures (such as Texas and Mexican combining to form "Tex-Mex."

Culturally Situated Design Tools: User-controlled computer programs which allow simulation of indigenous or vernacular designs in visual or auditory media.

Ethnomathematics: The study of mathematical concepts and practices as they occur in various cultures, with particular attention to the translation from mathematics embedded in indigenous or vernacular designs or practices to their analogous representations in "mainstream" (i.e., Western) mathematics.

Heritage Culture: The culture that an individual envisions as their heritage; often nostalgic or mythic in comparison to the actual culture referenced.

Indigneous Culture: Typically refers to the culture of small-scale (non-state) societies that existed previous to colonial invasion or third-world nationalization.

Vernacular Culture: The culture of every-day life; often used to invoke "street smarts" or non-elite knowledge.

Race and the IT Workforce

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INTRODUCTION

As the existence of the present volume attests, gender is crucial in understanding the IT workforce. To stop there, however, would be to miss many other aspects of identity that influence issues of satisfaction, recruitment, retention and attrition in IT organizations.[1] In this article, I will focus on race[2]—one of the most salient identity characteristics for today's workforce. The goal is to summarize some of the research approaches from sociology, psychology, and management that have furthered our understanding of race. These perspectives are presented as possibilities for extending the repertoire of strategies for enriching our research on IT women, especially women of color.

BACKGROUND

As shown in Table 1, African Americans, Hispanic Americans, and Native Americans are still underrepresented in the U.S. IT workforce (Niederman & Mandviwalla, 2004); women of color in the IT workforce are even scarcer. While the Information Technology Association of America ("ITAA") and the National Science Foundation (Wardle & Burton, 2002) have funded initiatives focusing on increasing the diversity of the IT workforce, there is still a dearth of relevant research. There is evidence that U.S. IT organizations have problems attracting and retaining minorities (Tapia & Kvasny, 2004), not to mention promoting them (Igbaria & Wormley, 1992, 1995). These problems are exacerbated by differential access to technology in general—a phenomenon referred to as the "digital divide" (Compaine, 2001; Kuttan & Peters, 2003; Mack, 2001; Servon, 2002).

The demography of the IT workforce is also affected by characteristics of IT organizations. We know race as a cultural factor is important in the shaping of technology—in other words, technology and technology organizations are not race neutral. Nor are they colorblind, despite the majority of whites in the U.S. who believe otherwise (Gallagher, 2003). Research often treats race as a static individual trait, yet this is hardly reflective of the experiences of IT professionals. Researchers often separate out one identity element at a time, such as gender, or race, or age, and the literature has tended to emphasize simple, monolithic categories, such as "black" and "white." Of course, there are many other categories and combinations. The 2000 U.S. census was redesigned to allow citizens to check multiple boxes to identify themselves as multiracial. Nationwide, approximately 2.4% of the population, over 6.8 million Americans, checked two or more races, in dozens of different combinations (http://www.censusscope.org/us/chart_multi.html). By 2050, the rate of multiracial identification could increase to 1 in 5 (Lee & Bean, 2004). In typical organizational research, however, members of these groups are often too few in number to constitute statistically significant subgroups and must be removed from the population of research subjects (Cox, 2004). Hence, Asian American, Hispanic American, and dozens of multi-racial groups are

Table 1. Percentage by race, 2002

	White	African-American	Asian/Pacific Islander	American Indian	Hispanic
IT occupations	77.7	8.2	11.8	0.6	6.3
All occupations	83.5	10.9	4.0	0.9	12.2

Source: ITAA, 2003

excluded from research data. Individuals who do not "fit" the major categories become invisible. This problem is particularly acute for women of color.

The potential multiplicity of racial or ethnic self-identification can be affected by computer mediated communication technology, such as the Internet. Kolko, Nakamura, and Rodman (2000) note that in textual "cyberspace," visual cues that can identify race are invisible, but users can present themselves in a wide variety of different ways using textual cues and signifiers. Thus, people can construct identities in ways that were not possible IRL ("in real life"). However, Kendall (1998, 2002) has also found that "Gendered, classed, and raced identities continue to have salience in online interactions, with power relations often operating in much the same ways as they do offline, even when participants understand that people's online identities might differ from their offline identities" (1998, p. 150). Thus, while online identities can be fluid in a way that is different from offline identities, this does not necessarily extend to the power hierarchies in which identities (such as gender, class, race, or age) are embedded.

While novel in some respects, the fluidity of race in cyberspace is just the one of the more recent instances of the recognition of the socially constructed nature of identity in the research literature. Social psychologists have described the individual's identification with different groups:

Tajfel first defined social identity as "the individual's knowledge that he belongs to certain social groups together with some emotional and value significance to him of this group membership. (Hogg, Abrams, Otten, & Hinkle, 2004, p. 249)

Different group identities (such as age or ethnicity) might become more salient given the particular context, or at different times. Thus, it is misleading to think of a particular individual as having a single social identity group (such as "female"), since an individual will belong to more than one group, and the significance of these identifiers depends on the context. In practice, different sets of identities become salient at various times.

Perhaps the most challenging development concerns the acknowledgement that multiple identities related to race, class, or gender, should not be explored as separate elements. In people's actual experiences, aspects of identity are experienced together rather than severally. For example, Kvasny (2003) offers an analysis of the "triple jeopardy" that arises from the intersection of race, gender, and social class in the world of information technology through participant observation at an inner-city computer technology center. Such a theoretical (as well as methodological) approach can provide us with a far more nuanced understanding of the experiences of women of color in IT than approaches that rely solely on a limited number of racial checkboxes on a survey.

However, there are many hurdles that race researchers must overcome before their research is published (Cox, 2004). For instance, focusing on a non-white group can cause journal reviewers to reject such studies. Race studies can give rise to a number of methodological dilemmas, including sampling issues, or overlaying research constructs onto the accounts of the research participants (Cuadraz & Uttal, 1999). As He and Phillion (2001) have noted, during the research process, "previously reified formalistic notions of race, gender, and class" can be "shattered" (p. 47) since research participants do not fit nicely into the categories that have been created for them. Race researchers who strive to preserve the narratives and experiences of their research participants must also contend with issues of their own identity in the research process (McCorkel & Myers, 2003). Smith (2002) called for broader level qualitative analyses of race and the workplace as well as longitudinal studies, but added the caveat that the challenges of this type of research are myriad, including the problem of employer reluctance to participate and release information about the organization. However, organizational or occupational level studies (House, Rousseau, & Thomas-Hunt, 1995) are critical in understanding the dynamics of the workplace, as discussed in the next section.

MESO LEVEL: ORGANIZATIONAL CULTURE AND OCCUPATIONAL SUBCULTURES

Issues of race and identity take on significance against a background of organizational cultures and occupational subcultures. Organizational cultures can play an important role in fostering an environment that is "warm" rather than "chilly" toward minorities and other underrepresented groups (Roldan, Soe, & Yakura, 2004). An important part of this effect is created through sheer numbers (Kanter, 1977). As the ratio or percentage of a particular group increases, the comfort level generally increases for members of that group. Because numbers are important for comfort, under-representation of minorities creates a self-perpetuating problem for the IT workforce.

Similarly, the culture of an occupation can be chilly towards women and minorities. For example, the ITAA report (2003) notes that women and minorities might not consider IT as a profession: "Females and minorities may feel isolated or unaccepted in the IT profession" (p. 6). Consider the stereotypical white male "geek," who represents a "prestigious stigma" (Moore & Love, 2004) in IT subculture, but may appear less than prestigious to women of color (see also Camp, 1996). Within an organization, occupational subcultures (Trice, 1993) can exist which foster attitudes that are implicitly or explicitly exclusionary.

Even in an organization with a high percentage of women, the comfort level for women of color may be quite low. Attempting to address problems of attraction and retention of minority IT professionals using policies that target a single identity factor will not always help. For example, any single initiative targeted for women may not help women of color. Furthermore, the process of attempting to accommodate women runs the risk of alienating men (as well as some of the women). To address these concerns, we need to foster cultures that are less stereotypic and simplistic in attitude.

Stereotyping operates in many different ways in the IT workplace. In addition to the obvious effect of generating bias, it can set up invidious comparisons among workers. For example, consider the impact of the "model minority" (Cheng, 1997) stereotype on the IT workplace. Asian Americans are often considered "excellent" in IT-related work, a thesis that sets up an implicit hierarchy of stereotypical expectations vis-à-vis other ethnic groups within the organization. As researchers (Cheng, 1997; Woo, 2000) have indicated, depending on how data on Asian Americans in the workforce are analyzed, arguments can be made that either support or defeat the thesis that Asian Americans are socioeconomically successful. For example, aggregating the data on Asian Americans as a whole "perpetuates a picture of high achievement" (Woo, 2000, p. 32). Stereotypes that reproduce and perpetuate these kinds of misunderstandings are damaging not only to those stereotyped but also to other dominant or non-dominant groups (see also Frankenberg, 1993).

Stereotyping is not the only area of concern regarding perceptions. We tend to think of racial stereotyping as a potential source of bias in hiring or performance appraisal, but in some respects, double standards are more insidious. Foschi (2000) notes that, in contrast to direct evaluation bias, "double standards ... occur when evaluations have already been made and are accepted to be objective (i.e., exempt from evaluation bias). The use of double standards is thus a subtle exclusionary practice ..." (p.27). Thus, even where the inputs to an evaluation process are fair and unbiased, the outcomes may not be. Different cross-groups can experience different outcomes in downsizing (Spalter-Roth & Deitch, 1999), working shifts (Presser, 2003), workplace authority (Elliot & Smith, 2004), or promotional practices (Maume, 2004; Wilson, Sakura-Lemessy, & West, 1999).

FUTURE TRENDS

Projections indicate that the North American population and labor market will continue to diversify (Fong & Shibuya, forthcoming; Grieco & Cassidy, 2001). Surveys by organizations such as the ITAA will continue to highlight this issue, and focus attention on the need to do more in terms of attracting and retaining a diverse set of employees. NSF funding initiatives will also aid in providing necessary resources for research that has been neglected in the past.

Our research must continue to deepen our understanding of the different identity groups that abound in the workforce. In particular, research that illuminates the complexities of the interactions and intersections of multiple identities (McCall, 2005) can enhance our ability to attract and retain more and more diverse sets of people in the IT workplace. Of course, understanding issues at the intersection of gender and race involves novel and complicated challenges for researchers as well as managers. While statistical research can provide useful information for examining changes in the IT workforce, qualitative and interpretivist research strategies will be required to address these challenges. While these approaches are not always easier or simpler, the additional efforts will be repaid with better outcomes for IT professionals and organizations.

CONCLUSION

Ideally, our research should reflect the complexity of individual identities against the backdrop of organizational, occupational, and even societal levels of culture. Monolithic, single-factor models of identity fail to capture key aspects of the experience of women of color in the IT workplace. Researchers are just beginning to explore the nuances of the gendered (Wilson, 2002) and raced (Vallas, 2003) spaces of U.S. organizations, and a consistent and continuous effort is required to address the negative and insidious aspects of issues of culture and climate as they affect women of color (Tapia & Kvasny, 2004; Taylor, 2002). For researchers committed to this deeper understanding of the experiences of women of color, this presents a difficult but ultimately more satisfying research process and outcome. This is not just an academic issue, but a practical problem as well that confronts IT organizations on a daily basis.

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KEY TERMS

Model Minority Stereotype: The stereotype that Asian Americans have achieved economic success.

Multiracial Identification: Identifying oneself as having an ancestry that includes more than one race or ethnicity.

Occupational Subcultures: Subgroups within an organization that share assumptions as members of an occupational group.

Organizational Culture: A pattern of shared basic assumptions that the group learned as it solved its problems of external adaptation and internal integration, that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to those problems (Schein, 1992, p. 12).

Race/Ethnicity: Groups that can be distinguished on the basis of ancestry and/or color (Lee & Bean, 2004, p. 223).

Social Identity: An identity which an individual has as a result of their acknowledgement of membership in a particular social group; an individual can have multiple social identities.

ENDNOTES

[1] This discussion is limited to the U.S. context, since other contexts, such as more homogeneous societies of Japan or Korea, would have a very different workforce demographic.

[2] As Lee and Bean (2004, p. 225) have noted, "Today, social scientists generally agree that race is a social rather than biological category and have documented the processes by which ethnic and racial boundaries have changed throughout our nation's history." In their review, they (p. 223) chose to use term "race/ethnicity" to refer to "groups that distinguish themselves on the basis of ancestry and/or color." In this article, for the sake of brevity, I use the term "race" as shorthand for their term, "race/ethnicity."

Reasons for Women to Leave the IT Workforce

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INTRODUCTION

Turnover has been a major issue among information technology (IT) personnel since the very early days of computing as well as nowadays (Moore, 2000; Niederman & Summer, 2003). IT personnel have a strong tendency to frequently switch employers. Annual turnover in the information systems (IS) field ranged between 15% and 20% during the 1960s and the early 1970s. In the late 1970s, the turnover was as high as 28% annually and around 20% in the early 1980s. By the 1990s, the turnover rate reached 25 to 33% annually (Jiang & Klein, 2002). Many large American companies had a 25 to 33% turnover rate among their IS personnel in the late 1990s (Hayes, 1998). Although *women* represent an increasingly important segment of the labor force, their turnover rate can exceed 2½ times the turnover rate of men (Chusmir, 1982; Cotton & Tuttle, 1986; Davis & Kuhn, 2003; Giacobbe Miller & Wheeler, 1992; Schwarz, 1989). A meta-analysis by Cotton & Tuttle (1986) of 120 datasets showed strong evidence for gender differences in turnover: women are more likely to leave their job than men. Gender differences in turnover are less consistent among nonmanagerial and nonprofessional employees, and are stronger among professional (Cotton & Tuttle, 1986). However, recent evidence suggests that educated women start resembling men with regard to turnover rate and pattern (Griffeth, Hom, & Gaertner, 2000; Royalty, 1998). Educated women are more likely to leave to take on another job, while less educated women are more likely to abandon the labor force (Royalty, 1998). Furthermore, part of the higher turnover rates for women can be explained by individual variables that turnover studies conducted by economists and focused on industry do not consider, such as age, tenure, marital status, occupation and salary (Giacobbe Miller & Wheeler, 1992). In this chapter, we look at gender differences in reasons why IT personnel want to leave their job, and in their intentions once they have left their job.

BACKGROUND

Age, tenure, and number of dependents are negatively related to intention to leave one's organization (Cotton & Tuttle, 1986; Griffith et al., 2000). Married employees are less likely to quit than unmarried persons (Cotton & Tuttle, 1986). The effect of education on turnover is ambiguous. Results from meta-analysis show education to be positively related to turnover (Cotton & Tuttle, 1986). However, some studies have found a negative relationship between education and turnover (Cotton & Tuttle, 1986; Porter, Steers, Mowday, & Boulian, 1974). Salary is negatively related to turnover (Cotton & Tuttle, 1986). We also know that demographic variables have direct effects on work-related attitudes such as job satisfaction (Compton, 1987; Igbaria & Greenhaus, 1992). Age and organizational tenure are positively related to satisfaction and involvement (Cotton & Tuttle, 1986; Igbaria & Greenhaus, 1992). Education has been found to be negatively related to satisfaction (Igbaria & Greenhaus, 1992; Parasuraman, 1982), and organizational involvement (Mottaz, 1988). Demographic variables have direct effects on turnover intention beyond their effects on turnover intention through satisfaction and involvement (Igbaria & Greenhaus, 1992; Parasuraman, 1982).

An important question rarely addressed in the literature is: where do women go after they leave their job? In a study on gender differences in turnover intention, Giacobbe Miller and Wheeler (1992) found that turnover intention among women was twice as high as men in comparable occupations. However, after controlling for age and job dissatisfaction, the gender effect disappeared. The researchers also found that meaningfulness of work was a strong predictor of intention to leave for women. We found similar results in a study on gender differences in job and organizational factors as predictors of quality of working life (Hoonakker, Marian, & Carayon, 2004b). For female employees in the IT department of a large public organization, task identity was one of the most important factors explaining gender differences in quality of working life (job strain, job commitment, and job satisfaction). A study by Allen, Drevs, and Ruhe (1999) looked at reasons why college-educated women change employment. The top three reasons were promotion, better pay/opportunities, and relocation (marriage/family). When asked what the employer could have done to make the respondents stay in their position of employment, the three most important suggestions were: to provide more pay or recognition (25%), to change working conditions (19%) and to move to another position (16%). The study by Giacobbe Miller and Wheeler (1992) showed that for both men and women, promotional opportunities predict intention to leave. In our study, we found similar levels of turnover intention among women and men (Hoonakker, Carayon, Schoepke, & Marian, 2004a; Schoepke, Hoonakker, & Carayon, 2004). Female IT employees perceived job and organizational characteristics and quality of working life in a manner similar to men. There were no gender differences in job satisfaction, organizational involvement, tension, fatigue and burnout. However, we found important differences in the factors that predict turnover (i.e., pathways to turnover) (Hoonakker et al., 2004a). For men, three pathways played an important role in predicting turnover: (1) the pathway from IT demands to emotional exhaustion to turnover (partly mediated by job satisfaction); (2) the pathway from challenge, career opportunities and rewards to job satisfaction to turnover; and (3) the pathway between rewards and turnover intention (also partly mediated by job satisfaction). Supervisory support did not play a significant role for men, but played a significant role in turnover of female IT employees. Supervisory support is related to nearly all the job and organizational characteristics, has a direct effect on turnover intention, as well in the pathways that are mediated through emotional exhaustion and job satisfaction. Job satisfaction also plays a central role for women: it is highly related to turnover intention, and many of the pathways to turnover intention are mediated by job satisfaction (Hoonakker et al., 2004a).

MAIN THRUST OF THE ARTICLE

Methods

We used a Web-based survey to collect the data (see Barrios (2003) for a detailed description of the Web based survey management system). A total of five IT organizations participated in the study: one large organization (N>500), one medium sized company (N=200) and three small companies (N<100). A total of 624 respondents responded to the survey (56% response rate). Twenty-seven cases in the sample had missing data on gender and were not used in the analysis. For the analysis reported in this chapter, we used data of 324 male employees (54%) and 273 female employees (46%). Respondents vary in age from 20 to 68 years (mean=39.7 years). The majority of the sample is married (61%); 9% is living with a partner; 1% is separated; 6% is divorced, 1% is widowed and 9% is single. Fifty-six percent of the respondents have children; 83% of the respondents who have children have children that still live at home. Forty-three percent of the respondents have one or more children younger than 7 years. Ten percent of the women and 2% of the men have a part-time job. Fifty percent of the men and 38% of the women telecommute or work remotely from their office.

Turnover intention was measured using a single item: "How likely is it that you will actively look for a new job next year?" on a 7-point scale (1: not at all likely-2-3: somewhat likely-4-5: quite likely–6-7: extremely likely) (mean=2.87, sd =1.83). Twenty questions were asked about reasons why respondents would leave their job. Five questions were asked about intention after leaving the job: (1) intention to look for another job at the same company; (2) looking for a similar job at a different company; (3) looking for another job at a different company; (4) no more job in the IT industry; and (5) no intention to look for a job at all. The questionnaire has been shown to be reliable and valid (Carayon, Schoepke, Hoonakker, Haims, & Brunette, 2006).

Results

Overall, there are no gender differences in turnover intention (see Figure 1).

Figure 1. Turnover intention

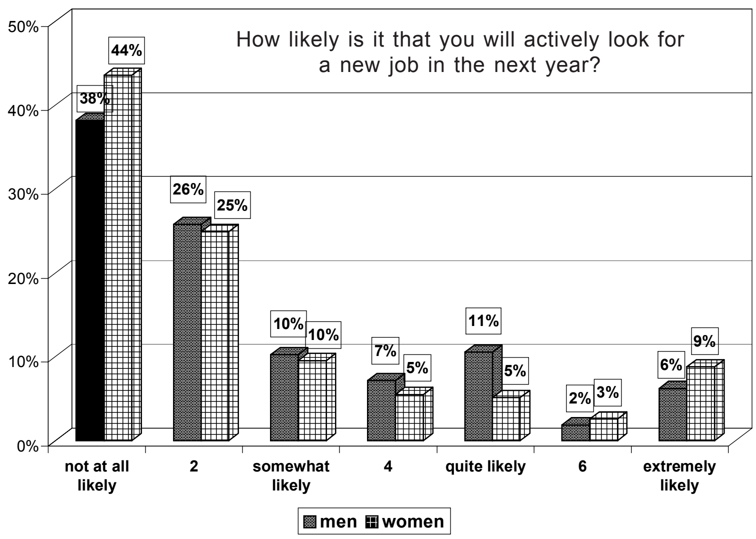

Table 1. Reasons for leaving one's job (percentages and rank)

	Men	Women	Total
High job demands	13%	16%	14%
Long working hours	15%	18%	16%
Lack of challenge or boredom	32%	31%	30%
Lack of social support	7%	11%	9%
Inadequate flexible work practices**	12%	20%	15%
Conflicts between work and family***	14%	25%	18%
Ineffective management	32%	33% (5)	31%
Feeling discriminated against**	5%	10%	7%
Feeling of not fitting in	7%	12%	9%
Lack of training	20%	15%	17%
Lack of development opportunities	29%	25%	26%
Inadequate rewards/reviews/raises	36% (4)	29%	32% (5)
Inadequate career advancement	31%	27%	28%
Want a higher job status	27%	21%	24%
Want to advance my career*	44% (2)	36% (3[t])	39% (3)
Want a higher salary**	55% (1)	44% (2)	48% (1)
Want a better compensation plan**	27%	18%	22%
Want to obtain more expertise	35% (5)	36% (3[t])	34% (4)
Want the opportunity to learn new things	41% (3)	45% (1)	42% (2)
Want more challenge in my job	26%	28%	26%
Other reasons…	10%	12%	11%

Notes: [t] Tied; Difference between men and women significant at the 0.05 level (*), 0.01 level (**) or 0.001 level (***)

There are gender differences in reasons why respondents would leave their job (see Table 1). The most important reason for leaving one's job is the wish for a higher salary: this reason is significantly more important for men than for women. For women, the most important reason to leave one's job is the need to learn new things in the job: this is the third reason why men want to leave their job. Other important reasons to leave one's job include: wish to advance one's career; wish to obtain more expertise; inadequate rewards/reviews/raises; and ineffective management. Conflicts between work and family, inadequate flexible work practices, and feeling discriminated against are more important reasons for women than for men to leave one's job.

There are gender differences in intention after leaving one's job. Table 2 shows the results for the following question: "If you'd decide to leave your current job, what would be your intentions? (Please check all the intentions that apply)". Men are significantly more often than women interested to stay in a similar type of job, but more likely to move to a different company or to move to a different IT job in a different company (47% vs. 38%, p=0.02). Women are more likely than men to look for another job within the same company (42% vs. 36%, p=0.006). Women are more likely than men not to look for another job at all (10% vs. 6%, p=0.02).

We conducted a series of analyses to predict turnover intention. First, we looked at objective variables: age, tenure, education, formal and informal IT education, salary, job type (managerial vs. professional), job title, marital status, children, number of children still at home, and number of children age six or younger. In general, both men and women are *less* likely to look for another job when they still have children at home. In a second analysis, we entered the objective variables in step 1. In step 2 we added reasons for leaving one's job (see Table 3).

Table 3 presents the Odd's ratios for seriously looking for another job. An Odd's ratio represents the likelihood for an event to occur, in this case looking for another job. An Odd's ratio greater than 1 means that the chance for an event to occur is higher. For example, the Odd's ratio for looking for another job for men who feel they do not fit in is 4.44: men who feel they do not fit in are four times more likely to look for another job. Odd's ratios less than 1 mean that the chance employees will look for another job is lower than average. For example, the Odd's ratio for female employees with children at home will look for another job is eight times (1/0.12=8.3) lower than average the changes that women without children will look for another job.

Results show that age, marital status, education, and years of tenure with employer and in current job do not predict turnover intention. Male employees with children at home are less likely to look for another job; but male employees with children younger than six years are slightly more likely to look for another job. Female employees with children at home are also less likely to look for another job. Employees who want a higher job status, who want to advance their career and who want more challenge in their job are more likely to actively look for another job. Employees who complain about ineffective management and employees who feel not fitting in are also more likely to look for another job. Employees who experience work/family conflict are less likely to look for another job.

Results also show some interesting gender differences. For women, the wish to have a higher job status is one of the most important reasons to look for another job; while for men the wish to advance

Table 2. Intentions after leaving one's job

	Men	Women	All
I would intend to look for a different type of job in my same company	36%	42%	37%
I would intend to stay in a similar type of job, but move to a different company*	47%	38%	42%
I would intend to be in a different IT job in a different company**	28%	19%	23%
I would intend to no longer work in the IT field	20%	17%	18%
I would intend not to look for another job at all*	6%	10%	7%

Note: Difference between men and women significant at the 0.05 level (*) or 0.01 level (**)

Table 3. Predictors of intention to leave one's job

		Men	Women	Total
Step 1	Age	1.14	0.86	0.98
	Marital status (1 = non-single, 2 = single)	0.98	1.13	1.07
	Children (0 = no, 1 = yes)	1.97	4.72	2.59*
	Children at home (0 = no, 1 = yes)	0.17*	0.12*	0.24*
	Children < 6 year (0 = no, 1 = yes)	3.49*	1.35	1.94
	Highest level of education	1.21	1.12	1.06
	Formal IT education	0.95	0.84	0.92
	Informal IT education	1.22	1.07	1.12
	Tenure (in years for employer)	0.73	0.82	0.69
	Experience (in years in current job)	1.40	1.16	1.44
	Job type (1=professional, 2 = managerial)	1.32	0.69	1.02
	Job title	0.93	0.97	0.96
Step 2	High job demands	0.68	0.85	0.74
	Long working hours	2.76	0.69	1.27
	Lack of challenge or boredom	1.33	0.88	1.06
	Lack of social support	1.01	0.37	0.72
	Inadequate flexible work practices / options	1.16	0.84	0.96
	Conflicts between work and family	0.19*	0.63	0.39^
	Ineffective management	2.16^	2.37	2.41*
	Feeling discriminated against	1.92	2.73	2.20
	Feeling of not fitting in	4.44*	2.49	3.34*
	Lack of training	0.95	1.95	1.58
	Lack of development opportunities	0.62	0.58	0.55
	Inadequate rewards / reviews / raises	0.96	3.08	1.25
	Inadequate opportunities for career advancement	1.32	1.74	1.64
	Want a higher job status	1.58	3.27^	1.98*
	Want to advance my career	2.57^	1.08	1.95^
	Want a higher salary	0.70	1.01	0.74
	Want a better compensation plan	0.67	0.37	0.57
	Want to obtain more or different expertise	0.77	0.42	0.54
	Want the opportunity to learn new things	1.72	2.17	1.82
	Want more challenge in my job	2.29	2.92	2.37*

Note: Difference between men and women significant at the 0.10 level (^) or 0.05 level (*)

their career is one of the most important reasons to look for another job.

FUTURE TRENDS

High turnover of skilled IT personnel, especially among women, remains a problem for IT organizations. Part of the high turnover rates for women can be explained by a number of variables such as age, tenure, marital status, occupation and salary. Moreover, recent studies suggest that educated women start resembling men in turnover rate and pattern (Griffeth et al., 2000; Royalty 1998). Women in our study are higher educated than men, although they still lag behind men with regard to specific IT education. They are less likely to hold computer-related bachelor's and graduate degrees (see also the article by Carayon, Hoonakker, & Schoepke on "Gender Differences in Education and Training in the IT Work Force" in this encyclopedia).

CONCLUSION

In our study we do not find gender differences in turnover intention, but we find gender differences in intention after leaving one's job and in reasons for leaving one's job. We also found some gender differences in reasons that predict turnover intention. Our results suggest that men follow a different strategy than women in order to achieve their professional and personal goals. Men are more likely than women to look for another job with *another company* when they leave their job. Women tend to look more often for another job within the *same company*. The reasons for leaving one's job vary between men and women. This result confirms our earlier findings that show that different job and organizational factors predict turnover intention for men and women (Hoonakker et al., 2004a). Therefore, IT organizations need to adapt their retention strategies to the specific needs of men and women.

R

NOTE

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KEY TERMS

IT Organization: An organization is a group of people intentionally organized to accomplish an overall, common goal or set of goals. An IT organization is an organization where information technology is used to accomplish the common goal or set of goals. This definition is much larger than the definition for an IT company: a company that produces information technology (hardware and/or software). Estimates show that 90% of IT employees are employed in non-IT companies, such as hospitals, banks and insurance companies.

Job Satisfaction: Describes how content an individual is with his or her job. There are a variety of factors that can influence job satisfaction, such as the level of pay and benefits, perceived fairness of the promotion system within a company, the quality of working conditions, leadership and social relationships, and the job itself (i.e., variety of tasks, challenge in the job, and the clarity of the job description/requirements).

Meta-Analysis: A statistical technique for combining and comparing results of many studies.

Quality of Working Life (QWL): Represents the quality of the relationship between employees and their total working environment, with human dimensions added to the usual technical and economic considerations.

Task Identity: The extent to which employees do an entire piece of work (instead of small parts) and can clearly identify the results of their effort.

Turnover: The movement of workers in and out of employment with a particular firm. Turnover intention is an employee's intention to leave the organization.

Web-Based Survey: In the broad sense of the notion of a survey, any Hypertext Markup Language (HTML) form that solicits input from respondents can be considered a survey. In our definition, a Web-based survey is a well-defined questionnaire, that has been proven to be reliable and valid in research and that, with the use of HTML, is put on the Web and solicits responses from specifically sampled respondents.

R

A Reflexive Analysis of Questions for Women Entering the IT Workforce

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INTRODUCTION

There are many resources available for young college graduates entering the workforce. Colleges and universities have entire departments and buildings dedicated to the process of moving students into the "real world." Questions such as "what should my salary be?" "which firm is rated the best in the country?" and "how do I fit into the corporate environment?" are typically asked by both male and female students and are answered by the staff. Yet given that business is generally a male dominated field, questions such as "have you encountered a glass ceiling in your career?" are less likely to be answered with the whole truth. Hence, this article seeks to answer some of the questions that women may have upon entering the information technology (IT) workforce.

As a woman who is graduating from college and preparing to enter the IT workforce, I[1] constantly ask myself questions about what it means to be a minority in a male dominated industry. In order to be prepared for my future career, I synthesized my questions into three central issues of coping strategies, social networking and gender identity:

1. **Coping Strategies:** How do women cope with being minority, and what do women do when treated unfairly because of their gender?
2. **Social Networking:** When should social networking begin, and how does a woman form a personal network?
3. **Gender Identity:** Do women have to display more masculine traits to get ahead in the IT workforce, and does business attire matter?

These questions are of importance because they are typical of the kinds of questions that a woman entering the IT field may have. Hence, the purpose of this article is to address these questions through a reflexive analysis in order to better prepare myself and others for careers in the IT workforce.[2]

MAIN THRUST OF THE ARTICLE

In order to address the questions raised previously, two primary sources of data are included in this article. First, a literature review is included that identifies the main themes of social networking, coping, and gender identity. Incorporated in this review are other resources that readers can use for additional information on the topic. Second, a reflexive analysis of the first author is included that details personal reflections from transcribing 25 qualitative interviews with American women working in the IT workforce[3] and from internships at a local school district and a large financial services institution.

Coping Strategies

According to Merriam-Webster Online (2006), *coping* is defined as "deal[ing] with and attempt[ing] to overcome problems and difficulties." This definition is interesting because it addresses two aspects of coping, both dealing with and overcoming problems. With regard to the IT workforce, it is important to have strategies to deal with and accept issues. Since coping is not always the easiest thing to do, it is important for women to consider coping strategies they might utilize as minorities in a male dominated industry.

Menaghan and Merves (1984) argue that most coping studies look at direct action on environment or self, interpretive reappraisal regarding environment or self, or emotional management. Dornbusch and Scott (1975) suggest that three types of workplace coping exist for employees: (1) leave an organization; (2) lower expectations; or (3) communicate dissatisfaction to the authority system and suggest changes in conditions. Fennell, Rodin, and Kantor (1981) argue that responses that create change are considered constructive, yet occur infrequently. Likewise Lim and Teo (1996) add that most coping does not require change, but primarily support from others.

These authors' arguments align with Trauth's (2004) research on coping strategies used by women in the IT workforce. Trauth explains that women in the IT workforce utilize three forms of coping: assimilation, accommodation, and activism. Assimilation accounts for the lack of stress because one is not aware of gender issues or uses selective perception to deal with hostile situations. Accommodation is the management of gender issues by recognizing the unequal treatment, but not taking action regarding the environment. Activism is the heightened awareness and the attempt to alleviate stress of gender issues through an active tendency toward changing the situation.

Based on a reflexive analysis of the interview transcriptions, it appears that some women in the IT workforce use group support as a primary means of coping. Perhaps people tend to feel better being around those who have similar beliefs, problems, and conflicts. Many of these women stated that they value social networks that allow for issue discussion and resolution. Other women in the interviews attempted to change their behaviors and actions to fit those of the group, such as taking on an activity that others in work are participating in, so they can have something to talk about. Furthermore, some women tended to take matters into their own hands. When faced with workplace issues, these women said something to their manager or co-workers in order to bring the situation to the attention of others. At times they found that by speaking up, others in their organizations realized the problems that were occurring, and progress was made in attempts to correct them.

Social Networking

There are two main social networking theories. The first considers the strength of weak and strong ties. This theory was created by Mark Granovetter in his 1973 article, "The Strength of Weak Ties." The article is one of the most cited works in social network literature. His main argument is: Our acquaintances *(weak ties)* are less likely to be socially involved with one another than are our close friends *(strong ties)*. Thus the set of people made up of any individual and his or her acquaintances comprises a low-density network (one in which many of the possible relational lines are absent) whereas the set consisting of the same individual and his or her close friends will be densely knit (many of the possible lines are present). Put another way, actors gain novel information from less intimate ties than close ties because actors who are strongly connected share information directly; therefore, they possess the same knowledge. New information comes from external connections which are likely to be weak.

Another social networking theory builds upon the weak tie relationships of Granovetter and discusses structural holes within social networks. Developed by Robert Burt in 1992, structural hole theory means that an actor is in a more advantageous position to gain and control novel information if s/he is connected to others who themselves are not directly connected to one another. The more non-redundant connections an actor has, the more information will flow with greater efficiency and with little constraint (Burt, 1992). The theory was developed to explain interpersonal communication within a competitive environment.

Based on a reflexive analysis of the interview transcriptions, it seems as though several women had their own ideas of how to build their social networks, including taking up new hobbies. One woman even went to the extreme. Her colleagues all took flying lessons and they would talk about it at work. She went out and took lessons, too, and could then join in their conversations. While it is not recommended for women to change their lifestyles to fit that of those they work with, adding some additional activities could be beneficial. If coworkers take a half day on Friday or meet Saturday mornings to play golf, perhaps a woman should think of taking up lessons. If not, do not feel as if you must keep at it to impress anyone. The next step would then be to find people in the company who do things that you are interested in. This is where the strong social networking skills come in. [4]

When transcribing the interviews, I also found it interesting that several participants considered why woman would want to be part of the "old boy's club." The participant viewpoints on male social networking were numerous and diverse. For example, a few women seemed to perceive female networks as less effective and lacking the power of male networks. There was also the belief that many women did not want to network with other women because they were afraid to share their secrets. Some women enjoyed being the minority, especially if that uniqueness earned them certain privileges. Other women did not like to stand out, and said that blending in with men is the easiest way to not draw attention to oneself in an organization.

Gender Identity and Attire

Sex or gender roles in our society are characteristics that actually differentiate the sexes, are stereotypically believed to differentiate the sexes, or are considered to be differentially desirable in the two sexes (Lenney, 1991). Saunders and Stead (1986) argue that manner of dress has increasingly been used by women to overcome unfavorable gender stereotypes and to improve their employment opportunity and advancement. Likewise, Forsythe, Darke, and Cox (1985) explain that female attire is an important factor in hiring decisions and career advancement recommendations. Furthermore, Malloy (1976) argues that the appropriate business uniform for men is more narrowly defined than it is for women.

In the transcripts, the women interviewed expressed a number of themes about masculine and feminine gender identity and attire. As much as we may hate to admit it, clothing is very important to perception within a company. Although the days of dressing like a feminized version of a man are over (e.g., Annie Hall), we still have to be conscious of what we wear to work. Because the styles of clothes change with the seasons and years for us, there are more choices. But, are those choices correct for entering the workplace? The Milan outfits from Ralph Lauren or Dior do not showcase shirts, pants, or skirts that are appropriate for the office. Most of the clothes that come off the runways are not ready to wear. In the age of *Sex and the City* and *Project Runway*,[5] what is a girl to do about shopping for work? Not so long ago, it was socially unacceptable for women to wear pants to work. It was all about the power suit, the navy blue or red blouse/jacket with the mid-length or long skirt. Pants were seen as inappropriate for a woman, leading to other stereotypes about women. Now, pants suits and separates are the most common business attire for women. There are many stores now that specialize in clothing for the professional woman.

In my experiences, what I wore at work was very important. During my job working for a school district, when school was not in session, the technology staff was allowed to wear casual clothes. It was brought to my attention that I was not allowed to wear shorts that were "too short" or any other articles of clothing that would be revealing. I felt offended because this was brought up before I was even able to wear casual clothing. Nothing like it was mentioned to the males I was working with, and I thought that it was unfair. I also paid close attention to what I wore when I worked for a financial institution. Historically, the banking industry is very conservative in the way employees are supposed to dress. The IT section of the company was "business casual."[6] For men it is easy—khaki slacks and a polo or a dress shirt without a tie. However, I found it interesting when I received the dress code policy, that the number of things that a woman could or could not wear was much longer. In my situation, I found myself dressing more towards business professional than business casual because I felt that my co-workers would take me more seriously that way. I noticed that the executives, both male and female, still wore the power suits, even when others around them looked like they were going golfing. I learned that clothing creates an image, and looking polished and professional is important.

There is also more to gender identity than clothing. The biggest example of gender identity that I have encountered is the way that women act in the professional IT world. During my internship experience, the functional manager for my group was a woman. Several teams besides mine reported to her, and she had only been with the company for six years. There were several team members who had been there much longer. She told me that she still felt like a newcomer in the organization, and I found that interesting, because to me, six years is a long time to be somewhere. My team members and I were discussing an issue that was handed down from the functional manager, and they were saying that she liked to have everything a certain way, and that they did not like it that she was that strict and demanding. I made note of the fact that our direct manager did not expect anything less than that from us, and the only difference was that he was a man. I said that maybe she felt that she had to act that way for them to take her seriously or that they were being overly critical because she was a woman. They all said that they had not thought of that before, and that makes sense.

FUTURE TRENDS

The Center for Women and Information Technology (CWIT) at the University of Maryland, Baltimore County, recommends the following courses of action for those women entering the IT field looking for avenues for discussing issues such as those discussed in this article:

- **Network by Joining an E-Mail Discussion List for Women in IT:** If you join one that serves the area where you live, you should be able to make some helpful personal contacts. To find a local list for women in IT, check out the listings at WorldWIT (http://www.worldwit.org) or the chapters of the Association of Women in Computing (http://www.awc-hq.org/chapters.html). Many of these discussion groups have e-mail lists and monthly face-to-face meetings. If regional discussion lists are not available in your area, try a national list such as SYSTERS (http://wwwsysters.org).
- **Learn More about Women and the IT Workforce through Gender-Related Electronic Forums:** A list of international and national forums on women related issues in science and technology can be found at CWIT's Gender-Related Electronic Forums (http://research.umbc.edu/~korenman/wmst/forums.html).
- **Attend Regional Events Offered through Area Organizations:** The Association for Women in Computing (http://www.awc-hq.org) is a national organization with local chapters that usually offer regular meetings, e-mail lists, and workshops.
- **Find a Mentor:** To find out more about what mentors do and how they can help, visit MentorNet (http://www.mentornet.net/).

CONCLUSION

Social networking seems to be the biggest method of coping. This can mean that a woman either accepts the problems and talks to someone about them, or that a woman looks to change them. Finding a mentor in the organization is an excellent method for coping with an uneven playing field. Women should prove what they can do. There are several examples of women not being taken seriously, and then performing well on a task, and gaining the respect of their coworkers. Most of the time, unfair treatment is the result of lack of respect. Women should pit themselves in positions to make a difference and to be noticed.

With regard to social networking, maybe the answer is not breaking into the "old boy's club," but creating a women-centered club. Other women in a company who feel the same way you do. Maybe there already is a network, and you just need to join. Get to know your coworkers and the women in higher-ranking positions. Have lunch with them, or seek them out on a coffee break. Knowing others within the organization can help when it comes time for promotions and reviews. It also helps to look outside of your direct company. There are lots of resources on the Internet for building networks of women. There are several conferences that offer opportunities for growth of both your business and networking skills. When you first start with a company, inquire as to the types of programs offered for women. "Is there an on-site daycare for children?" is often a good question to start off with, because if a company does this for its employees, it generally means that there are other opportunities as well.

With regard to gender identity and attire, before you start working, ask what the dress is like for the company. Most IT departments of large corporations have moved towards business casual, but that does not mean that your look needs to be casual. It is written more for the men, letting them know that they do not have to wear a tie and jacket around the office. In the more conservative fields, such as banking and some consulting firms, business professional is still active. If you are unsure of what to wear, dress on the conservative side until you have learned what is appropriate.

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KEY TERMS

Coping Strategies: Mechanisms used to address or overcome issues, problems, and/or difficulties.

Gender Roles: Characteristics that actually differentiate the sexes, are stereotypically believed to differentiate the sexes, or are considered to be differentially desirable in the two sexes (Lenney, 1991).

Individual Differences Theory of Gender and IT: A social theory developed by Trauth (2002, Trauth et al., 2004) that focuses on within-group rather than between-group differences to explain differences in male and female relationships with information technology and IT careers. This theory posits that the underrepresentation of women in IT can best be explained by considering individual characteristics and individual influences that result in individual and varied responses to generalized environmental influences on women.

"Old Boy's Club": An informal social network where men are able to share information in an informal setting, in order to build trust, personal relationships, and career advantage.

Social Networks: The web of personal and professional relationships that people utilize to exchange resources, information, and services.

ENDNOTES

1 Use of first person in this article refers to the first author whose voice is reflected in this article. The second author contributed to the writing, and the third author collected the empirical data used in this article.

2 This article is based on a research paper that was a requirement of a directed study course with Eileen M. Trauth, PhD, in the final year of the first author's undergraduate degree program.

3 The transcribed interviews are a part of a National Science Foundation study on gender and the IT workforce (grant number: EIA-0204246; principal investigator: Eileen M. Trauth, PhD). The purpose of this study is to engage in development of the Individual Differences Theory of Gender and IT (Trauth, 2002; Trauth et al., 2004).

4 Additional information on social networking in this dataset can be found in Morgan, Quesenberry, and Trauth (2004).

5 *Sex and the City* and *Project Runway* are two American television shows.

6 *Business casual* refers to office clothing that is not as professional as a suit, but more professional than jeans. An example of business casual is dress slacks with a button down shirt.

R

Retaining Women in Undergraduate Information Technology Programs

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INTRODUCTION

While the experiences of women in computer science (CS) are well documented (Cohoon, 2001, 2002; Computing Research Association, 2002; Margolis & Fisher, 2001), information technology is a relatively new discipline (Denning, 2001; Mitchell, 2002) and does not enjoy the same level or scope of inquiry. This study focuses on women in undergraduate IT programs and attempts to identify the factors involved in the attrition of women from these programs. In Phase 1 of this study, all freshman IT and CS women as well as a random sample of IT men at an eastern university (15,000 students) were interviewed and asked about their experiences in the IT program. These interviews were qualitatively analyzed, and the results are currently being used to develop a national survey of women in undergraduate IT programs. The primary research question of this study is, What factors are most influential in the decision of female students in IT undergraduate programs to enter these programs, and, where applicable, what factors most influence their decision to leave the programs during their first year of study?

BACKGROUND

Attrition in both undergraduate and graduate programs has been shown to be significantly different across academic disciplines; Cohoon (1999) demonstrated the differences between gendered attrition rates in CS and Biology. As a result, IT programs will not necessarily have attrition rates that are comparable to (or based on the same factors as) those in CS. While the literature contains numerous examples of research into gendered differences in CS, these examples are not sufficient to identify issues in the IT population, but they are more than adequate as a foundation for this inquiry.

Literature Review

In one of the earliest large-scale studies of differences in educational attainment by sex, Alexander and Eckland (1974) confirmed what many women already knew then and now: “a relatively strong and unmediated depressant sex effect remained for the educational attainment of women ... ” Based on a longitudinal study of 2,077 women who were high school sophomores in 1955 and a follow-up in 1970, the results indicated that even with controls for a wide variety of variables (background, performance, self-esteem, etc.), evidence suggested that sex was negatively related to college attendance and achievement in school.

To explore a more generic model of academic persistence, Tinto (1974) suggested a model predicting the “degree of fit” between an individual and college as strongly related to persistence and retention. Tinto based his model on the continuum of changing commitments and experiences of students based on the assumption that students entered school with specific backgrounds and varying levels of commitment to completion. His development of five different factors causally related to persistence provided the basis for subsequent research into gendered attrition: (a) background (family, gender, high school), (b) initial commitment (commitment to graduation or academic major), (c) academic and social integration, (d) subsequent goals and commitment, and (e) withdrawal decisions (persistence).

Pascarella and Terenzini (1983) conducted a longitudinal study from 1976 to 1978 of 1,457 students to examine Tinto’s theory. Students were surveyed at three data points to collect information about their freshman-year experience. Interesting differences between men and women appeared in the effect of initial goal commitment. While both men and women demonstrated that initial goal commitment positively influenced subsequent goal commitment, women also demonstrated a strong relationship between initial goal commitment and both social integration and persistence. Significantly, social integration appeared to have a stronger influence on female persistence than did academic integration (with the reverse being true for men).

Stage (1989) followed suit with an exploration of the Tinto model using another longitudinal study conducted between 1984 and 1985. Focusing on motivational orientation as related to initial commitment, Stage recognized seven categories (certification, cognitive, community service, change, social, recommendation, and escape), with the majority of respondents being classified into the three largest subgroups: certification (i.e., the goal is to earn a degree or get a job), cognitive (the goal is to learn and grow), and community service (the goal is to gain skills and experience in helping people). In the certification and cognitive categories, gender appeared as significantly correlated to social integration.

In 1997, with the publication of "The Incredible Shrinking Pipeline" (Camp, 1997), an examination of the decline of female enrollment in CS was underway with urgency. In 1997, Fisher, Margolis, and Miller also examined the experiences of women in CS using factors like persistence and motivation. Interestingly, Fisher et al. decided to let the students speak as "expert witnesses in their own world." West (2002) also talked with women (in this case, in an introductory programming course). Additionally, *Unlocking the Clubhouse* (Margolis & Fisher, 2002) was highly influential in both discovering and describing the experience of women in an undergraduate CS program.

Other studies like Beyer et al. (2003), Liu and Blanc (1996), and Scragg and Smith (1998) have also employed survey methodologies to gain data and insight into the experiences of women in CS.

MAIN THRUST

Methodology

The underlying technique for data collection and analysis of interview results in Phase 1 is the sense-making model developed by Brenda Dervin (1992). This technique is based on situating individual decisions and choices along a continuum of time and space. In other words, as students journey through their academic experiences, they encounter what Dervin calls "gaps" that force the successful bridging of these gaps or decisions to pursue completely different paths (thus skirting the gaps). Troublesome situations (Dervin & Clark, 1987) are defined as "any situation ... where a person faces some kind of gap preventing a movement ahead." Conversely, helps are defined as those experiences, people, activities, thoughts, ideas, and/or resources that successfully bridge any gaps.

The interview technique allowed for asking open-ended questions that focus on what Dervin (1992) considers the significant questions. For example, what stopped this person from accomplishing goals, what information or bridges were sought, and what assistance was ultimately necessary or lacking? Based on the situation, the gap, and the help, a sense-making triangle encircles experiences and provides a context for examination and discussion. This sense-making triangle forms the basis of the time-line interview. In the interview, students are asked about their experiences and, using open-ended questions, encouraged to talk at length about the situation, the gaps, and the helps.

Study Design

In Phase 1 of the study, 33 respondents were invited to participate (10 IT women, 13 CS women, and 10 IT men). One hundred percent of freshman women in both the IT and CS programs agreed to participate. The 10 men who agreed to participate were randomly selected from the entering freshman class of 200 freshman men. Each participant agreed to sit down for a face-to-face interview in the fall and spring quarter, as well participating in e-mail exchange during the winter quarter. This design allowed for three data-collection points. Respondents were given a cash incentive for the fall and spring interviews. All interviews were taped and transcribed for later analysis.

For the second phase of the study, two surveys are underway. Beginning with the ACM SIG-ITE membership list, schools offering a BS in information technology were identified and solicited to answer a demographic survey about their IT programs. Questions in this survey included faculty, student, and institutional descriptors. This survey also requested data about the number of women entering the IT program over the past 2 to 5 years, current FTE enrollment, the number of women known to have left the program (transfers out of the program or departures from the institution), and graduation rates.

Running concurrently during Phase 2, an individual survey will be administered to individual women enrolled in the identified IT programs; it is scheduled to be distributed at the beginning of the 2005 to 2006 academic year. Survey questions, under development, are based on the qualitative analysis of interview transcripts conducted in Phase 1 of the study.

Analysis

Coding the transcripts was based on the key components of sense making (situation, gaps, and helps). Trees of coding terms (nodes) were created so that passages could be broadly or narrowly identified as appropriate. One example is Helps/People, or more narrowly, Helps/People/School/Counselor. Two passes were used through the transcripts: The first pass coded each appropriate passage with terms, while the second pass combined terms as required. For example, Gaps/No Money and Gaps/Cost were combined into Gaps/Financial Considerations.

The fall and spring transcripts were lengthy and frequently ran over 40 pages in length. Students spoke freely and openly, but often diverged from the structure of the interview instrument. Extracting the key information from the transcripts was difficult and required focus and attention to detail. Conversely, the winter e-mail exchanges were more structured and required less sifting and winnowing. Comparable amounts of relevant data were obtained despite the difference in length. In retrospect, the e-mail exchanges forces a certain focus on the question at hand and reduced the judgment calls of the interviewer significantly. The use of e-mail allowed the interviews to be iterative, and allowed both the researchers and the participants to take time for reflection between responses.

After two passes through the transcripts, nodes were reviewed for frequency and distribution in each population (i.e., how many men, IT women, and CS women mentioned this topic in their interview). Differences in the conceptual framing of the topic were also apparent as in the case of women who identified counselors as playing a dual role as help and gap (depending on the situation).

CONCLUSION

Some of our preliminary findings confirm work by previous researchers in gendered attrition. For example, while the impact of guidance counselors and teachers is important to both men and women, women more frequently identify counselors as negative factors in pursuing an IT major. And, in keeping with other research into gender differentials in retention, none of the men interviewed cited concerns about proper preparation for their studies, while two of the IT women and four of the CS women indicated that was a concern in their decision-making process. This concern persisted for the women throughout their first year.

Of unique interest is an early indicator that while female students in both CS and IT described frustration with programming classes (as opposed to men who infrequently indicated issues with programming), the IT women also expressed a sense of irrelevance about programming and doubts about how programming fit with their career goals. In contrast, the CS women more frequently accepted programming as both relevant and important to their career goals.

Analysis of the Phase 1 transcripts is ongoing and is expected to finish by the summer of 2005. These results will then be used to identify and develop questions for the Phase 2 national surveys. Upon completion of the national survey, quantitative analysis of the results will provide a basis for programmatic activities and future directions for retaining women in undergraduate IT programs.

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KEY TERMS

Attrition: A reduction in membership, number, or strength.

Coding Nodes: The process of examining interview transcripts and assigning classification information and/or descriptive terms to excerpts of the textual information.

Motivation: Any inducement or incentive that improves persistence.

Persistence: Continuation or continuance.

Qualitative Analysis: The process of discovering and/or assigning meaning based on descriptive narratives.

Sense Making: A theoretical approach to interviewing that examines the continuum of decisions and choices along time and space.

Troublesome Situation: Any situation that involves a gap or some other problem that prevents a person from moving ahead in time and space.

APPENDIX: THE INTERVIEW INSTRUMENT

Thanks again for agreeing to participate in this study! I'd like to start by gathering some basic information about you. As we discussed, this information will be kept completely confidential; only broad characteristics, such as your age and gender, will be linked with your replies in the research results. Your name will not be stored with any of the replies you provide. Where necessary in the reporting of results, even this demographic information below may be masked or "genericized" in order to protect your identity.

Age:
Hometown:
Other members of home household (parents, siblings, etc.):
Parent(s) occupation:
Computer in your house? If yes, what years? What kind?
High School
 Public/Private?
 Size of graduating class?
 Did your high school offer programming or computer classes?
 If yes, did you take any of those classes? Which one(s)?

Now that we have the general framework of information in place, I want to ask you some specific questions about the events in your life leading up to your decision to go to college, and particularly your decision to come to school here. As we proceed, you may have some particularly strong memories, and I'd like to hear all of them. I have a questionnaire structure which guides how and when I ask you about different parts of your memories. By using this structure, we can compare your experiences with others', while still allowing you to share details that are unique to your particular experiences.

What I'd like for you to do now is to choose a situation that occurred in the past that related to your decision to attend college, and where you felt that you were in some way blocked or hindered from accomplishing your goals or getting the information you required. The "block" could take the form of a person, a bureaucracy, a rule, a lack of a specific item, or any number of things. This situation could be a discussion with a family member, friend, or colleague; visiting a campus; reading an article or book; or simply an occasion when you were particularly focused on the idea of going to college. It's important that you be able to recall the situation clearly, and reconstruct the questions and thoughts that you were having at the time. I'll give you a minute or two to choose the situation and recall the details. Feel free to write it down.

(Here's an example: Suppose I'm in a grocery store, and have just wheeled my cart into the produce section. That is my specific situation, one that I can picture in my mind. I'm blocked because I can't find anyone to answer my questions about the produce.)

When did this situation occur? (An approximate date is fine.)

Can you describe the situation for me?

In the situation you just described, how did you see yourself as blocked?

Now I'd like you to go back in your mind and try to identify what the questions you had in your mind at the time were. By questions, I mean things that you wanted to find out, learn about, and come to understand, unconfuse, or make sense out of. You need not have asked the question out loud, nor found an answer; we simply want to identify gaps in understanding that you faced at the time. These may not have been in your mind as questions, but rather as unclear aspects of the situation or your feelings. In these cases, what I need you to do is to translate that aspect into a question, or to simply talk about that aspect so that together we can translate it into a question. Take a few minutes to think about the questions. Feel free to write them down.

(In the grocery store situation I used as an example, my questions might be: Where are the avocados? Is that man in the bright green plants an employee? Are mushrooms still $3.00 a pound? I wonder if the corn is as good as it looks? Etc.)

Now, thinking about your situation, what questions did you have in your mind?

Let's talk about the specific questions that you listed. As we go through this process, you may think of other questions that were in your mind at the time. If so, feel free to add them to the list as we go, and we'll talk about them as well.

APPENDIX: THE INTERVIEW INSTRUMENT (CONT.)

We're going to start by looking at the motivations behind each of your questions. By that, I mean what you were trying to accomplish or understand by asking the question.

(Going back to the grocery store example that we used before, when I entered the produce department and asked if the mushrooms were still $3.00 per pound, what I might have been trying to do was decide whether or not to get mushroom for myself because I like them, but I was worried about paying too much. Or I might have been curious because even though I don't like mushrooms, it is interesting to me that some people will pay up to $3.00 per pound for them, like maybe that guy in the green pants.)

Given that, think back to when you asked [insert question here]. What was it that you were trying to do by asking this question?

When you had this question in your mind, did you see yourself as blocked or hindered in some way?
If yes, how did you see yourself blocked?

Were you able to find an answer to this question?
If yes:
Was it a complete or a partial answer?
How did you get the answer?
How did the answer help you?
If no:
What do you see as having prevented you from getting an answer?
How do you think the answer could have helped you?

Repeat for each question.

Okay, that's all for this interview.

Is there anything you'd like to add at this point, or questions that you have about what we just discussed?

Thanks again for your participation. We'll be back in touch with you in January for the second part of the interview. As a "thank you," here's the $25 that you were promised. You'll receive the $25 at the end of the school year, after our third interview with you.

If you have any questions about the research process, please feel free to contact us—

Schema Disjunction Among Computer Science Students

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INTRODUCTION

In her book *Why So Slow?: The Advancement of Women*, Virginia Valian describes a schema as "a set of implicit, or nonconscious, hypotheses about … differences." (Valian, 1998). Individuals use schemas about particular social groups to guide their interpretations of and behavior toward members of those groups. However, problems can arise when multiple conflicting schemas are applied to the same person. This phenomenon, *schema disjunction*, is particularly well illustrated by the situation of female undergraduate computer science majors.

Extensive interviews with introductory computer science students of both genders reveal a significant discontinuity between their schema of women and their schema of successful computer scientists. Despite professing conscious egalitarian beliefs about the ability of women to do computer science, many students unconsciously hold disjunct schemas that help facilitate an environment hostile to novice women and may deter them from pursuing computer science careers (Pedersen-Gallegos, Laursen, Seymour, Donahue, Crane, DeAntoni, et al., 2004).

Valian argues that, starting in childhood, we acquire *schemas* through observation of adult behavior toward others. Schemas are generally more inclusive than stereotypes and carry fewer negative connotations: They are not necessarily unfair or pejorative. In fact, schemas are a normal way that humans use categorization to negotiate our environments. However, Valian also explains that schemas can become unjustly misrepresentative of individuals due to errors that creep in during their development. These errors are then reinforced during maintenance and application of those erroneous schemas. These generalized beliefs about certain types of people are often unarticulated, and may be even consciously disavowed by those who hold them. Yet people can still operate unconsciously on the basis of ingrained schemas while remaining unaware of them.

Because schemas color our interpretations of people we interact with, they also shape how we behave towards those people. We treat each other, and ourselves, in accordance with our schematic expectations. When these expectations are unfairly pejorative, they can have a damaging impact on the self-concepts and lives of the people to whom they are applied, often resulting in a self-fulfilling prophecy. Echoing Cooley's (1902) classic notion of the "looking-glass self," Valian describes this phenomenon with a focus on gender schemas:

All of us—boys and girls, men and women—become in part what others expect us to become, thereby confirming hypotheses about the different nature of males and females. While no one is infinitely malleable, no one is completely *indifferent to others. One way we learn who we are is through others' responses to us. As men and women, we also develop expectations for our own behavior, based on characteristics we believe we possess. We then explain our successes and failures in terms of those abilities and traits.* (Valian, 1998)

BACKGROUND

The report *Attracting and Retaining Women in Information Technology Programs* reports on a study done for the National Science Foundation by Ethnography and Evaluation Research at the University of Colorado at Boulder. To illuminate some of the obstacles to achieving gender equality in the field of computer science, we undertook in-depth qualitative interviews with a wide variety of computer science (CS) students and faculty (Pedersen-Gallegos et al., 2004). Interview subjects included students who were just beginning their studies and those who were nearing completion of a CS major or minor. All interviews were tape-recorded and transcribed *verbatim* into *The Ethnograph*, a computer program that allows for multiple, overlapping and nested coding of a large volume of transcribed documents, and supports analysis to a high degree of complexity. This discussion draws primarily on data from 70 introductory students, including both undergraduates who had persevered in the discipline and those who had left it or chosen alternative programs. All uncited quotations in this article come directly from those interviews.

THE INTERVIEWS

We asked the students we interviewed to tell us what they thought made a successful computer scientist. We also gleaned their impressions about what women are like through their conjectures about why there are so few women in the discipline. Questions about gender issues were asked only at the end of interviews with students, so as to make a clear distinction between gender issues and more generic learning issues. One of the most striking findings, especially among students at the introductory levels, was that although most students professed egalitarian beliefs about women's rights and abilities to be computer scientists, the characteristics they considered schematic of a computer scientist were often antithetical to those included in their schema of a woman.

Comparing the novice students' descriptions of computer scientists to their implied beliefs about women, we can see how the schemas of these two groups stand in opposition to each other, as illustrated in Table 1.

Table 1. Students' schema for computer scientists and for women

Students' Schema for Computer Scientists:	**Students' Schema for Women:**
Highly intelligent	Find CS difficult or intimidating
Inherent passion for CS	Natural interest in arts and humanities
Early experience with math, science, computers	Inexperienced with math, science, computers
Self-motivated, independent learners	Communal and social learners
Logical, analytical thinkers	Less spatial and abstract thinkers
Poor social skills - "Nerd" image	Concerned with social image
Competitive and driven	Less competitive, more nurturing
Focused on prestigious, challenging careers	Less concerned with career success
Can handle the long, stressful hours of a programming job	Want more balanced career, opportunity to raise a family
Represented among faculty/discipline	Underrepresented among faculty/discipline

Students we interviewed described traits that they considered as characterizing good computer scientists or facilitating success in the discipline. Their answers provided a picture of the computer scientist schema held by introductory level students. Both men and women described a typical computer scientist as fitting the traditional "computer geek" image — brainy but shy, scatterbrained and lacking in social skills. "Even other engineers make fun of computer science students for their nerdiness," one student admitted. Students also described computer scientists as members of an extremely intelligent, prestigious elite, with access to high-status careers, such as "being a rocket scientist." Most students considered this reputation a key element of what it was to be a computer scientist, priding themselves on their prestige and often on the very "geekiness" associated with it. This echoes the finding of Seymour and Hewitt that engineering students prided themselves on the "hardness" of their discipline as a source of status (Seymour & Hewitt, 1997).

Students also identified a variety of specific experiences, skills and personality traits that they saw as constituting the "CS type." They told us that success in CS depended on a prior interest in computers and programming, especially a passion to pursue the subject. This desire was seen by many as something that could not be learned, but rather was inherent to CS types. Another strongly held image of the CS type was that of the self-motivated, independent programmer. Several students related archetypical CS anecdotes, combining both passion and independence, about how they or students they knew had taught themselves much of the material needed for success in CS courses, often before coming to college:

None of the people I know started coding in high school, they started coding when they were like in middle school or something, and then they kept coding in high school, and they probably would ace [the introductory CS course].

In addition to being self-motivated learners with strong drives to master the material, students' computer scientist schemas often included intellectual aptitudes, such as having a natural facility for math, science or foreign languages. They cited more general ways of thinking as well, such as having a logical, linear or analytical mind. Not only did students list traits linked to programming ability itself, they also considered certain personal characteristics necessary for surviving the rigors of CS *education*. These included an ability to learn quickly and independently, a willingness to challenge oneself and an early development of fluency with CS basics. Finally, they saw successful CS students and computer scientists as capable of handling a high level of stress, using it as a motivating factor rather than as a hindrance. This also corresponds to Seymour and Hewitt's finding that engineering students valued their own ability to "hack it" by tolerating large amounts of stress.

We asked students, in addition to delineating the characteristics of any successful computer scientist, to explain why women might be underrepresented or struggle in the discipline. Regardless of the gender of the respondent, their hypotheses illuminated similar pictures about what women are like. Quite a few students of *both* genders believed that women have inherent biological or psychological traits that limit their potential for success in the CS major, while others saw them as being unjustly but no less insurmountably limited by their socialization and cultural location.

Supporting Valian's assertion that both women and men hold detrimental gender schemas, nearly equal numbers of men and women made statements in interviews about women's "natural" aptitudes or inclinations. Some students suggested that these characteristics arose through a process of socialization, or had been culturally reinforced. However, they were nonetheless seen as inescapable and deterministic of women's beliefs and choices. For example, one student suggested that the toys and games little boys play with could engender neurobiological development different from that of little girls.

The most common assumption was that women's enrollment in CS was low because women are "naturally less interested" in technical fields, preferring arts, humanities and the social sciences. Further claims reinforcing a schematic disjunction were that women are less able than men to think spatially and abstractly, that women are naturally less competitive, and that women tend to have less focus and drive toward their careers. They also believed that women were more concerned with their social lives and ability to make friends, and suggested that some might be put off from CS and other engineering disciplines for fear of being stigmatized as anti-social "nerds."

Not all students believed that women suffered from in-born disadvantages when it came to CS. In almost equal numbers, they suggested that women were at a disadvantage due to cultural factors or were limited by aspects of their upbringing and roles imposed upon them by society. Regardless, students retained an image of women as being disadvantaged, lacking the social and cultural resources necessary to succeed. The most common attribution among this group was that men made better CS students because they tended to have more experience with math and science, due to encouragement at an early age:

You go back to elementary school, and you know, the teachers are concerned when little boys don't do well in math, but when it's little girls, it's, "Oh, okay, that's all right, ... girls aren't good at math."

Men were seen as often being more conditioned than women into a mindset that facilitated success in CS. Their early encouragement in math and science gave them more exposure to frustrating, detail-oriented tasks and fast-paced learning environments similar to those they would later encounter in CS. Meanwhile, students suggested, women's socialization might lead even those with a potential talent for CS to be intimidated by the math needed to pursue a CS degree.

These schematic characteristics correspond with Valian's description of the schema of women, which includes being expressive, communal, social and aesthetic, as opposed to men, who are seen as agentic (capable of individual, autonomous action), assertive, task-oriented and analytic (Valian, 1998). Due to these two schemas being largely comprised of diametrically opposed characteristics, women can often have trouble simultaneously reconciling their gender identity with their identity as a computer scientist. As one student told us, "… even just in engineering, a lot of girls won't tell people immediately that they're engineers. Especially when they're trying to meet guys." Jane Roland Martin (1994) also paradigmatically makes this point with her assertion that women in science face a "double bind."

CONCLUSION

Although most students claimed that the knowledge and skills needed for CS could be learned by anyone, frequently this belief was held concurrent with the view that only a certain type of person inherently "has what it takes"—in terms of personality, perspective and drive, as well as technical ability—to be a successful computer scientist. Regardless of the potential of any real individual woman do CS, introductory CS students demonstrated beliefs about women as a category that were in clear opposition to their beliefs about computer scientists. The images students had of female attributes did not resemble those they saw as needed by successful CS majors.

The persistence of this schema disjunction is understandably inimical to women's inclusion and success within CS programs. It is not the accuracy of the ascribed traits that is of critical concern, but the damage these expectations do to women who take them to heart. These women may exclude themselves from entering the major, or enter but then struggle more than their male peers with feeling accepted and capable.

Of course, not all women are intimidated out of the discipline by a feeling of not belonging. The schema disjunction is exacerbated and reinforced by a complex system of social factors, some unique to CS and some more universal, for which there is not room to address here. However, this interplay of diverse factors may occur in ways that are more or less detrimental to particular women. Furthermore, some women do develop strategies for persevering in the discipline. Although this article cannot describe these strategies in full depth, they generally involve the individual privileging one or the other of the schematic groups as a more fundamental part of her identity: either somewhat rejecting her identity as a woman in favor of seeing herself as a computer scientist, or else strongly and consciously identifying her gender as an especially relevant element of her CS experience.

One hopeful and illuminating finding: More advanced female students, given several years of personal experience with the realities of what success at CS actually entails, tended to see fitting the CS schema as less crucial to the identity of a computer scientist than their less experienced peers. These students had a much broader view of what CS is about, and emphasized that most useful traits are learnable rather than innate characteristics of an elite "type." It appears that, through experience in CS, they eventually found ways to reconcile their identities by altering their schemas rather than their self-concepts.

However, a strong belief in the standard schemas was still prevalent among students at the introductory levels, and thus more likely to impact novice students' experience of belonging. Consequently, those who did not initially feel like they "fit in" sometimes dropped an introductory course or switched out of the major before they had a chance to truly gauge their own individual potential and desire to succeed at CS.

Sustained effort continues to research and understand the relative dearth of women and other underrepresented groups in STEM disciplines such as CS. A complex web of interrelated factors operates to limit access to and success in CS by members of these groups. Although untangling that web necessitates simultaneous work in many areas, *schema disjunction* is one relevant contributing factor. Even if CS students do not consciously hold that particular women necessarily lack the capacity to *do* CS, they still express a background belief that *people like women*—those who exhibit traits deemed characteristic of *real* women—do not fit the necessary description to *be* real computer scientists. The persistence of this view, especially among students at the novice level, makes introductory CS an understandably discouraging environment for any young woman exploring her options.

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KEY TERMS

Boys' Club Mentality: A form of elitist atmosphere that is male-oriented to the extreme of implicitly rejecting and excluding women.

Computer Geek: As used here, the stereotype of a single-minded programmer, who is brilliant with computers but socially inept. Computer science students used the term affectionately, admitting that, while an exaggeration, it has some truth to it, and is even considered a badge of honor to some extent.

In-Group: A collection of people defined as close to and similar to oneself. Fellow members of a social set.

Out-Group: A collection of people defined as distant from and other to oneself. Not a member of a particular social set.

Schema: A set of implicit assumptions or generalized hypotheses about members of a given social group.

Schema Disjunction: An incompatibility between two or more schemas when they are applied to the same person or group.

Self-Fulfilling Prophecy: A situation in which certain expectations held by a person or persons end up becoming true only because the people in question become (consciously or unconsciously) aware of the expectations and adjusts their actions to meet them.

STEM: Science, technology, engineering and mathematics. A cluster of disciplines from which women and many ethnic minorities have traditionally been excluded, and in which they are currently underrepresented.

The Shrinking Pipeline in Israeli High Schools

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INTRODUCTION

Worldwide surveys indicate that the number of women studying undergraduate-level computer science (CS) has been constantly decreasing in the last 20 years (Camp, 1997, 2002; Camp, Miller, & Davies, 1999; National Center for Education Statistics, 2004). According to Galpin (2002), the low participation of women in the computing studies is recognized worldwide. As it turns out, the situation is similar among high-school students as well (Davies, Klawe, Nyhus, Sullivan, & Ng, 2000). However, while many studies are carried out at the university level and programs are implemented in order to change the situation, high-school students do not attract such attention. In Israel too, as far as we know, no research has ever been performed that focused on female high-school students studying CS. This article presents such a study. Specifically, it focuses on high-school female students studying advanced-level CS.

Based on data collected in Israel, significant differences were found in the percentages of female high-school students studying advanced-level CS among different sectors. More specifically, while the percentage of female high-school students studying advanced-level CS is about 50% for the Arab minority sector, the percentage of female students studying CS at the same level among the Jewish majority sector is only about 25%. Different studies around the world identified various factors that discourage women from studying CS and from persisting in the field. By focusing on the Israeli high-school female students studying CS at the highest level and coming from two sectors, we suggest that the research presented in this article may partially explain the above-mentioned phenomenon. Further findings are presented in Eidelman and Hazzan (2005).

BACKGROUND

Margolis and Fisher (2002) suggest that the underrepresentation of women in the computing fields is important on two levels: on the personal level and on the societal-cultural level. Therefore, Margolis and Fisher suggest that the significant differences between the representation of women and men in the CS fields in general, and in high-school CS classes in particular, should not be ignored. This underrepresentation has a special significance in Israel, a small country in which the efficient utilization of its human resources is of great importance.

Underrepresentation of Women in the Computing Fields: A Worldwide Perspective

As mentioned in the introduction, the underrepresentation of women in the computing fields is recognized worldwide (Galpin, 2002). However, recent in-depth analysis of this phenomenon reveals that the problem is not universal, but rather is restricted to specific countries and cultures (Adams, Bauer, & Baichoo, 2003; Galpin; Lopez & Schulte, 2002; Schinzel, 2002). More specifically, in certain countries and cultures, such as Greece, Turkey, Spain, Portugal, Mauritius, Romanic countries (e.g., France and Italy), North African countries, Arabic countries, and South American countries, the representation of women in CS is high and constant in contrast to the United States, Israel, Anglo-Saxon countries, Scandinavian countries, and German- and Dutch-speaking countries, in which the representation of women in CS is relatively low and decreasing. Accordingly, it is reasonable to assume that cultural factors play an important role in encouraging or discouraging women from studying CS.

S

Underrepresentation of Women in the Computing Fields: An Israeli Perspective

As mentioned previously, a significant difference exists in the percentages of female high-school students studying advanced-level CS between the Arab and Jewish sectors in Israel. As it turns out, high school is a critical point in the CS pipeline, at which many female students, mainly in the Jewish sector, are lost. This situation encouraged us to initiate the research described in this article, which examines factors that influence the enrollment and persistence of Israeli female high-school students (of two populations, Arab and Jewish) in advanced-level CS studies.

The Israeli education system has a unique characteristic that may be useful for research works of this kind; that is, the Arab and the Jewish pupils learn in separate educational systems according to the same curriculum. One solution that has been suggested for countries in which women are underrepresented in CS (and that would like to change this situation) is to visit countries in which this problem does not exist, and to identify the cultural differences, as well as actions taken to encourage women to study CS, that may explain why women in such countries find CS an attractive field (e.g., Adams et al., 2003). From this point of view, Israel is a perfect place for such research. Specifically, in order to understand the low participation of Jewish female high-school students in CS, there is no need to visit another country. It is sufficient to investigate the differences that exist between the two populations, which live in the same country and, as has been mentioned before, study CS according to the same curriculum, one of which (the majority) suffers from this underrepresentation, while the other population (the minority) does not.

MAIN THRUST OF THE ARTICLE

This section describes the research setting and its results.

The research population consisted of 12th-grade CS students from nine typical high schools from both sectors (five schools from the Jewish sector, four schools from the Arab sector). Table 1 describes the distribution of the students according to gender and sector. CS teachers were included in the research population as well.

Table 1. Distribution of research population

	Total	Male	Female
Number of students from the Jewish sector	90	65 (72%)	25 (28%)
Number of students from the Arab sector	56	22 (39%)	34 (%61)
Total	**146**		

Three comparisons were conducted in the research: Jewish female students vs. Jewish male students, Arab female students vs. Arab male students, and Jewish female students vs. Arab female students. This article focuses on the differences between Jewish and Arab female students.

The research applied both quantitative and qualitative approaches. Data were gathered using the following research tools: comprehensive questionnaires that included closed and open questions completed by all students; ethnographic, semistructured interviews with 18 Jewish and Arab female students; and classroom observations during CS lessons (both lab lessons and traditional classroom lessons). In addition, interviews were conducted with CS teachers.

In what follows, we present the analysis of data, gathered by questionnaires and interviews, with respect to three topics: support and encouragement, future and success orientation, and the perception of CS.

Support and Encouragement

Several questions in the questionnaire addressed the support and encouragement to study CS that students receive from different sources. One of the questions was “Who encouraged you to choose CS studies?” for which the pupils could choose from a given list of figures more than one figure. Table 2 presents the distribution of answers to this question.

Table 2 reflects an unequivocal conclusion: Arab female high-school students receive much more encouragement to learn CS than do their Jewish counterparts.

In another question, the students were asked to rate their agreement with the following statement: “Our school encourages its students to study advanced-level CS.” The difference between the two

Table 2. Percentages of females' encouragement by others

Source	Jewish Female Pupils	Arab Female Pupils
Mother	40%	56%
Father	40%	44%
Siblings	16%	44%
Friends	20%	40%
Acquaintances who had studied CS	20%	50%
Teachers	8%	56%

populations was significant (p=0.000): 91% of the Arab female high-school students agreed with the statement compared to only 28% of the Jewish female high-school students.

Additional evidence can be found in students' answers to a question in which students were asked to rate the influence of different factors on their choice to study advanced-level CS. The results are presented in Table 3.

A similar picture emerges also from students' answers to open questions. For example, a Jewish female student explained in an open questionnaire that:

[p]arents don't encourage the girls enough to begin studying CS and since the female students are influenced by their female friends' attitudes towards computing, they don't turn to CS studies (and not because of a lack of required skills, since they do have them).

The difference in the participation of female high-school students in CS studies between the two sectors is reflected not only in the number of female students attracted to study CS, but also in the number of female students that persist in their CS studies. As it turns out, Jewish female students are more likely, compared to their Arab counterparts, to abandon their CS studies during the high-school years (especially at the beginning of 12th grade, when the material becomes more complicated). In the interviews, the female students were asked about their own and their friends' persistence in CS studies. The Arab female students' attitudes to this

Table 3. Factors influencing the choice to study advanced-level CS

Factors	Jewish Female Students	Arab Female Students
Supporting and helpful CS teachers	1.2	2.4 *
School recommendation (teacher, counselor, principal)	1.2	2.0 *
Family recommendation (parents, siblings, uncles/aunts)	1.9	2.3 **
Friends' recommendation	1.4	2.3 *

*Notes: * (p<.01), ** (p<.03)*
Values range from 1 (no influence at all) to 3 (much influence). The table presents the averages.

Table 4. Factors influencing the choice to study advanced-level CS

Factors	Jewish Female Students	Arab Female Students
A matriculation certificate with CS will help me find a job	1.8	2.3 **
CS is an essential subject for academic studies	1.9	2.5 *

*Note: * (p<.01), ** (p<.04)*
Values range from 1 (no influence at all) to 3 (much influence). The table presents the averages.

Table 5. Intended academic major

Major	Jewish Female Students	Arab Female Students
CS related	31.8%	21.2%
Undecided	45.5%	9.1%
CS unrelated	22.7%	69.7%

issue further highlighted the importance of the support that they receive from their environment.

Future and Success Orientation

Interesting outcomes were revealed in students' answers to a question in which they were asked to rate the influence of future- and success-oriented factors on their decision to study advanced-level CS. Table 4 presents two such factors.

Table 5 presents answers to a question that asked about the field the students plan to major in for their academic studies. The results presented in Table 5 will be further discussed in the conclusion.

When asked about gender-related considerations involved in the choice of majors, some of the female Arab students stressed their duties as wives and mothers: "The boys consider how to earn a living, but the girls consider both how to earn a living and be at home."

At the same time, however, at the high-school level, female Arab students conceive CS as a way to increase their self-esteem. An Arab female student said:

CS is like I have a job. People will regard me as ... if I have a higher status ... There is a different perspective on a girl who is studying CS. There is more appreciation ... When my parents tell their friends that I'm studying CS it gives them more pride and appreciation.

Attitudes Toward CS Studies

A difference in the Arab and the Jewish female students' perspectives was observed also with respect to their conception of the field of CS. As can be seen in Table 6, the female students from the two sectors view CS in a significantly different way. Only 32% of the Jewish female students who are already studying advanced-level CS think that CS is important; a higher percentage of Arab female students think that CS is difficult and frightening, but yet a much higher percentage of Arab female students like and enjoy CS.

One of the questions in the questionnaire asked to rate factors related to attitudes toward CS studies according to their influence on the students' decision to study advanced-level CS. Table 7 presents several factors and strengthens the previous results.

Currently, the Jewish and Arab sectors in Israel study in separate educational systems. As mentioned previously, both educational systems have a similar structure in terms of the basic curriculum. In what follows, we explain the above findings through some of the structural differences that do, nevertheless, exist between the two educational systems.

High-school students can choose to specialize (advanced-level studies) in specific subjects taken from two groups: Group A includes the traditional scientific fields of mathematics, physics, chemistry, and biology, while Group B includes CS, economy, communication, psychology, sociology, languages, law, art, drama, music, tourism, and theater. As it turns out, the most prominent difference between the two educational systems is expressed in the diversity of the subjects offered at the advanced level. Both systems offer the same variety of Group A subjects; however, while most Jewish schools offer a variety of Group B subjects, most Arab schools offer very few subjects from Group B. As a result, when 10^{th}-grade students are required to choose specialization subjects for their high-school years, Jewish students have many options to choose from in Group B compared to Arab students who have less choices. Specifically, Jewish female students have the option of choosing traditional "feminine" subjects (like psychology) while Arab female

Table 6. Attitudes toward CS among Jewish and Arab female students

Attitude toward CS	Jewish Female Students	Arab Female Students
Interesting	68%	85% *
Difficult	16%	35% *
Essential	56%	38% *
Enjoyable	28%	53% *
Frightening	8%	21% *
Important	32%	77% *
Liked	8%	50% *
Surprising	0%	47% *

*Note: * (p<.01)*

Table 7. Factors influencing the choice to study advanced-level CS

Factors	Jewish Female Students	Arab Female Students
CS is a prestigious subject	2.0	2.4 *
CS studies is a challenge for success	1.9	2.4 *
I enjoy studying CS	2.1	2.4 *
Friends' recommendation	1.4	2.3 *

*Notes: * (p<.05)*
Values range from 1 (no influence at all) to 3 (much influence).

students are, in most cases, restricted to a choice of more "masculine" subjects (such as CS). Moreover, most of the other Group B subjects are considered by students to be easier and to require less effort compared to CS. Thus, for Jewish female students, the alternatives seem much more attractive.

This situation is reflected clearly in the interviews, in which the female students were asked, "Which subjects did you have doubts about when you had to choose your majors?" A typical answer given by a Jewish female student was:

I didn't choose physics, because I didn't really see myself there ... I didn't feel the connection in any way. And versus chemistry I had drama, so I preferred drama, because I felt a connection. Later I changed drama to social sciences and instead of physics I took CS.

Such answers clarify the idea that because of the alternatives that exist in the Jewish schools, the choice of CS is not trivial or obvious.

Ultimately, we see that the limited options in the Arab sector actually benefit Arab female students and expose them to prestigious areas, such as CS. At the same time, the existing diversity offered in Jewish high schools, while aiming to enable all students to study subjects according to their capabilities and areas of interest, draws female students away from CS. Well, subject diversity—is it good or bad?

FUTURE TRENDS

In this section, we briefly present several of the solutions suggested in the literature for the encouragement of women to learn CS, which may fit to the Israeli female high-school students: providing girls with early experiences with computing; conducting meetings or workshops for parents, teachers, and counselors to increase their awareness with respect to their influence on their daughters and female students to choose CS studies; carrying out direct attempts to recruit more female pupils into advanced CS studies; implementing mentoring programs in high schools; conducting classroom visits and talks by successful women in computing positions; including activities to increase female students' self-confidence; establishing diverse learning and working environments; creating all-female CS classes; and reversing the image of CS and refuting its stereotypes. This list of activities is based on the following resources: Gürer and Camp (2001, 2002), Jepson and Perl (2002), Leever, Dunigan, and Turner (2002), Margolis and Fisher (2002), and Verbick (2002). The potential influence of each of these activities may be a subject of future research.

CONCLUSION

As mentioned above, noticeable differences exist in the extent of encouragement Arab female students receive from various agents, especially from teachers, in comparison to Jewish female students. Even in light of the renowned, greater appreciation and respect given to teachers in the Arab sector (Sherer & Karnieli-Miller, 2004), the differences, we suggest, are still enormous. One possible explanation for such an extent of encouragement is based on findings of other studies that explored cultural and familial differences between Arab and Jewish adolescents. According to these studies, since Arab students are part of an Eastern, collective culture, as well as a minority group in Israel, it is likely that they are pushed by their parents to higher scholastic achievement in order to improve their social status (Peleg-Popko, Klingman, & Abu-Hanna Nahhas, 2003).

In addition, Arab students perceive their family environment as more authoritarian than do their Jewish counterparts. The hierarchical structure of the Arab family is based on age and traditionally requires the young to obey the old members and adhere to their expectations (Peleg-Popko et al., 2003). Furthermore, it was found that peer influence in the Arab sector is much more positive than it is in the Jewish sector, possibly because of the relative independence from family and friends that exists in the Jewish sector (Azaiza & Ben-Ari, 1997). This might explain the lower influence of parents and peers in the Jewish sector.

The picture painted by the results of our study is that Arab female students perceive CS studies as a way to provide themselves with increased professional opportunities and especially higher social status. This assumption is reinforced by results of general research regarding the future orientation of Arab adolescents, which concluded that Israeli-Arabs perceive high-school education as a crucial element in the opening up of employment opportunities and in achieving a higher economic status (Azaiza & Ben-Ari, 1997; Seginer & Vermulst, 2002). In order not to be inferior in the eyes of their family in particular and their society in general, it seems that Arab female students are highly motivated to study CS since they consider these studies as a way to prove their skills and capabilities.

Despite the fact that Arab female students are about half of the students in advanced-level CS classrooms in high schools, according to their future orientations (Table 5), this will probably not help to expand the shrinking pipeline in the Arab sector. Most of the female students have already decided on their future professions, and only a small percent of female Arab students consider majoring in CS. Thus, the better starting point might not carry over to higher education and industry.

Arab female students also hold relatively positive attitudes toward CS compared to Jewish female students. Since it was found that positive attitudes of the female students toward computing influenced the success of the students and their continued enrollment in computer courses (Charlton & Birkett, 1999; Gürer & Camp, 2002), the attraction and retaining levels of CS studying among the Arab female students is clear. By creating an atmosphere that supports the development of positive attitudes toward CS, we can probably attract more female students to study advanced levels of CS.

Furthermore, as has been discussed previously, different social and cultural characteristics stimulate the extensive encouragement the Arab female students receive. Naturally, we can conclude that encouragement may be one solution for attracting female students to study CS and keeping them there.

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KEY TERMS

Computer Science: The systematic study of algorithmic processes that describe and transform information: their theory, analysis, design, efficiency, implementation, and application (Denning, 1989). The *Computing Curricula 2001: Computer Science* volume, published on December 15, 2001 (http://www.computer.org/education/cc2001/cc2001.pdf), presents the following areas as topics in the computer-science body of knowledge: discrete structures, programming fundamentals, algorithms and complexity, architecture and organization, operating systems, Net-centric computing, programming languages, human-computer interaction, graphics and visual computing, intelligent systems, information management, social and professional issues, software engineering, computational science, and numerical methods.

Israeli High-School Computer-Science Syllabus: The syllabus includes the core of the discipline and is considered to be relatively advanced in comparison to the CS syllabi of other countries.

Shrinking Pipeline: The pipeline represents the ratio of women involved in computer science from high school to graduate school. The pipeline shrinkage problem focuses on several exit junctions: from high school to undergraduate school, at the bachelor's level and at the senior levels both in academia and the industry.

Skills of Women Technologists

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INTRODUCTION

Women technologists practice careers in various fields of information technology. They traditionally are educated and trained to acquire primarily technical skills. However, in response to organizational change and industry shifts, today's women technologists are acquiring a multitude of diverse skill sets—on top of their conventional technical skills—to excel and succeed in the workplace.

This article delves into various skill sets in today's IT workplace and how women technologists have adopted and updated their skill sets to redefine their role to align with today's industries.

BACKGROUND

Skills

A skill is defined as a proficiency, talent, or ability that is developed through training, education, or experience (Beckhusen & Gazzano, 1993, p. 10). Throughout a woman technology professional's career, a unique combination of on-the-job training, technical apprenticeships, internships, job shadowing, and formal education results in acquiring basic skills. This basic foundation later develops into specialized expertise through years of work experience (Gordon, 2000, p.133).

Skills vary in use and purpose. Beckhusen's et al. work (1993) on strategic skills assessment divides skills into five main categories. This assessment is an excellent baseline, which covers numerous skill sets of technology professionals. Some skills are transferable and portable, and thus are listed under multiple categories. The following are the seven main skills categories.

Creative Expression Skills

Skills in this category are designing, developing, authoring, composing, displaying, inventing, performing, and producing (Beckhusen et al., 1993). Skills of creative expression serves key for technology professionals involved in such roles as architecting software, designing user interface or developing new hardware. They use their artistic inclinations to develop innovative solutions and designs. Examples of technical professionals who have highly developed creative expression skills are software developers, Web designers, graphic user interface (GUI) designers, and research/development specialists.

Communication Skills

Skills in this category consists of consulting, facilitating, explaining, speaking, writing, interviewing, persuading, selling and motivating (Beckhusen et al., 1993). Communication skills are critical for successful interaction between various stakeholders of projects—from the client and all the way to the project team. Communication is vital throughout all phases of project management, planning, and development processes. Gill (2002) states that communication is a major determinant for the success or failure of a project. Brooking (1999) adds that in an organization, it is important to know "who needs to know what" and make sure they get the information they need at the right time they need it. Examples of these technical professionals with highly developed communication skills are project managers, functional analysts, business analysts, technical writers, documentation specialists, and system diagrammers.

Mental Creative Skills

Skills in this category consist of intuitive, conceptualizing, brainstorming, improvising, memorizing, synthesizing, and visualizing (Beckhusen et al, 1993, p. 10). Advances in technology that are results of using mental creative skills are expert systems that capture deep knowledge to derive conclusions based on if-then analysis (Brooking, 1999, p. 89). Examples of technology professionals that rely heavily on mental creative skills are software engineers, architects, project managers, quality assurance testers, systems assurance analysts, and performance capacity analysts.

Mental Analytic Skills

Skills in this category consist of analytical, budgeting, categorization, editing, investigating, observing, monitoring, researching, and problem solving (Beckhusen et al., 1993, p. 10). Mental analytical skills are used extensively during information management efforts that are both the responsibility of business experts as well as the information technology functions. Information is seen as having a key role in business processes (Evernden, 2003, p. 6-8). Examples of these technical professionals heavily utilizing these skills are database administrators, programmers, functional leads, business analysts, and systems analysts.

Leadership/Management Skills

Skills in this category consist of initiating, coordinating, deciding, delegating, implementing, organizing, mediating, negotiating, and supervising (Beckhusen et al., 1993, p. 11). These skills are used by developers and testers when coordinating a team, organizing a meeting and supervising progress. Furthermore, according to Cohen (2002), exceptional negotiation skills are at play when the team ends up mutually committed to fulfilling the agreement they have reached (Cohen, 2002, p. 3). Technical professionals having strong leadership skills are project managers, senior architects, lead system administrators, technical leads, and Web directors.

Physical Skills

Skills in this category consist of building, constructing, operating, and restoring (Beckhusen et al., 1993, p. 11). Physical skills are directly used by professionals dealing with computer hardware in performing troubleshooting, configuration, set-up and installation tasks. Examples of technology professionals requiring strong physical skills are computer technicians, PC operators, help desk support specialists, customer support representatives, telecommunications specialists, and infrastructure support personnel.

Humanitarian Skills

Skills in this category consist of advocacy, coaching, mentoring, counseling, instructing, listening, and training (Beckhusen et al., 1993, p. 11). Humanitarian skills include empathizing and building rapport with fellow project team members. Empathy is the art of relationship building and used by project team members to show their support for team performance. Rapport is insightfulness regarding other's feelings, motives, and concerns (Johnson, 1997, p. 230). These skills are exhibited by all technical professionals such as trainers, managers, team leads, and LAN administrators as they do their daily jobs.

SKILLS OF WOMEN TECHNOLOGISTS

Women technology professionals possess diverse and multiple skill sets that enable them to successfully work in their field. As industries and businesses evolve, today's organizations now need fewer yet far better educated and skilled workers due to technical advances in the workplace (Gordon, 2000, p. 2). Fields (2001) calls people who have a diverse set of skills "indispensable employees".

Field generalizes that most organization's ultimate goal is to recruit and retain these competent indispensable employees. In order to achieve this status, women technology professionals strive to have most or all of the skill categories above either as their core and/an secondary skill. The following sections differentiates core from secondary skills.

Core Skills

Core skills comprise of mental analytical skills. They are acquired through intensive technical training.

Core skills are specialized expertise in the areas of software, hardware, telecommunications, network, server, telecommunications, security, and Web services. Advanced math, logic, software engineering, CASE implementation, programming languages, data flow diagramming, decomposition diagramming, entity relationship modeling, data normalization, prototyping, structure charting, walk-through, testing are some examples of techniques, and strategies used that take heavily from mental analytical skills (Gordon, 2000, p. 9; Fletcher & Hunt, 1993, p. 154-155).

Secondary Skills

Secondary skills comprise the rest of the other skill categories—creative expression, communication, mental creative, leadership/management, physical, and humanitarian skills. Other secondary skills come about through interaction with the project team and intercultural collaboration. Skills in project management is gaining wider acceptance as IT departments become more projectized. This skill includes competencies in such techniques as critical path scheduling, PERT charting and GANTT charting (Fletcher, 1993, p. 154-155). Intercultural skills are also emerging to be an important secondary skill as multicultural and global teams increasingly being formed (Laroche, 2003, p. 58).

MAIN THRUST OF THE ARTICLE

Women technologists exhibit a strong sense of adapting multiple skills as their careers progress in the workforce. A single or combination of a variety of methods is employed by women to acquire these skill sets at various points in their career. The acquisition of skill sets is divided into two stages that directly correspond to the stage of a woman's career.

Skills Specialization Stage

This stage occurs during the initial 1-3 years of a woman's work experience. As a newly grad or a junior technical professional, she seeks to define her expertise in her specific line of work, function or environment. During this part of her career, successful women technologists specialize to carve their niche and build a reputation for themselves based on solid technical core skills. If success is not achieved immediately, she may seek specialized technical training to augment and/or update existing skills for her to move up in the corporate ladder. She may also consider acquiring professional certification, licensure, advanced degrees, joining professional organizations, and networking (Laroche, 2003, p. 57).

At this stage, successful women technologists have a strong belief in their ability to control their careers. Very often successful women have legitimate power to control their destiny, which would reinforce a personal sense of internality and career drive. Many of them say that they have the tenacity and perseverance which enabled them to strive hard consistently throughout their careers (White, Cox, & Cooper, 1992, p. 85, 62).

Skills Diversification Stage

This stage occurs after a woman has completed the skills specialization stage. Skills diversification usually occurs during the next 4-10 years of a woman's career. Upon mastery of specialized skills, she sets about to complete this next stage that extends her specialized skill set to include diverse and complementary general skills. Tanton (1994) assesses effective women technologists have a good mix of both their technical specialization and have strong analytical, financial, marketing, planning, project management, decision making, and people skills. Tanton refers to people skills as communicating, negotiating, motivating, listening, involving, counseling, and appraising and delegating skills. In this stage, women technologists usually act the role of technology knowledge workers, sources, and gatekeepers.

Women perform the role of technical knowledge workers by gaining an intrinsic knowledge about people and how they can work together to become better teams (Brooking, 1999, p. 38). Brooking added that since job titles often mask past knowledge about people, proficient women technologists are competent and have experience in identifying team resources based on networking relationships and working with them in previous teams. This skill adds value to products and services. Thus, women technologists who fulfill this role become key business assets that link jobs, knowledge, and profit in every organization (Gordon, 2000, p. 6-7).

Women also perform the role of sources by being identified as a person with more knowledge to solve problems and be creative than the rest of the group (Brooking, 1999, p. 102). Women technologists fulfilling this role are not only experienced in managing an IT environment, but also on working on custom application development on all levels. A source may also be characterized as a technologist who is multilingual and can speak the language of developers and the language of business experts to serve as the bridge across that gap (Gill, 2002, p. 135).

Lastly, women perform the role of gatekeepers by knowing how to get things done, how to solve a particular problem or remembering corporate historical literature (Brooking, 1999, p.105). A woman technologist's technical competence becomes less important, while her social skills become more important as her career progresses. The social skills of self-constraint and compassion are apparent in the ability to organize groups, negotiate solutions, empathize, and create rapport (Gordon, 2000, p. 50). These abilities taken together create skills that are seen as interpersonal intelligence. Women who possess high interpersonal intelligence can connect with people quite smoothly, be astute in reading the reactions and feelings, lead and organize, handle the disputes that result from human interactions (Johnson, 1997, p. 223-224).

ISSUES AND CONTROVERSIES

Quantifying the return of investment (ROI) on skills training is an issue management and organizations constantly face. Organizations admit that there is enormous value in investing in training of women technologists, however there a controversy on how to quantifying the results of skills training and effectively measure it back to the increased efficiency and dollar savings. Although many strategies have been proposed through the years, there is still difficulty in comparing skills knowledge management principles skills versus improvement of the bottom line.

A common complaint about skills training is it does not always bring the return or benefits that one might expect, given the huge sums invested especially when analyzing the ROI (Evernden, 2003, p. 61; Gordon, 2000, p. 49). ROI is an industry standard for how an organization weighs the cost of education versus compensation. It answers the question of what does the organizations get back in return for its investment (Mingus, 2002, p. 50). The results of skill training are not necessarily easily quantifiable, direct or concrete (Gordon, 2000, p.3).

Furthermore, skills training are unfortunately considered as just lip service among some organizations. It is sometimes largely dismissed for most employees as a burdensome cost that must be cut. Some CEOs, presidents and business owners still see no connection between company profits and investing in their human capital because they believe you cannot measure it (Gordon, 2000, p. 3). Organizations have continuously sought to quantify the increase in skill set by setting benchmarks and metrics to measure skills advancement. Although not concrete, some case studies show a relationship between training and profit increase (Laroche, 2003, p. 30).

Assimilation is also an issue for new women technologists. Assimilation is the process of adapting to the organization's culture, customs and attitudes. It involves the risk of bringing in a new person and finding out how well they blend in and fit with the corporate culture. If a new woman technologist finds it difficult to assimilate for whatever reasons, her colleagues might discount her knowledge no matter how valuable it is (Brooking, 1999, p. 95). This issue can be addressed by proper employer/employee matching and screening for a potential fit during the organization's recruitment process.

PROBLEMS

A shortage of mentors in their specific field willing to contribute to their skills development is a problem faced by women technologists. Mentoring is the process of giving advice on education, developing job related knowledge, advance competency and proficiency (Brooking, 1999, p.96). Due to limited number of practicing women technologists, there is also a shortage of available and willing women technical mentors. This is still prevalent today. However, trends show that efforts and awareness campaigns are underway to lessen the gap.

Aside from a shortage of woman mentors, there is also a general labor force shortage of specialized technical professionals. There is a huge skills gap between the technical proficiency necessary in the workforce and the labor force's actual general lack of know-how and skills. This skills deficiency has been identified for both female and male technologists (Fields, 2001, p. 20). A potential solution to this problem would be integrating technology into educational curriculum early on to encourage developing talent.

FUTURE TRENDS

Women technologists will continue to display a diverse set of skill set as their roles in the organization evolves and changes. The trend towards mastering their core skills first, then consistently refining their secondary skills will be prevalent in the future.

There will also be a continued emphasis on "techno-education", wherein educational curriculum will be heavily infused with technical subjects in order to expose students, increase awareness, and generate interest early on to information technology.

There will also be potentially increasing numbers of women entering the technology field as traditional job descriptions evolve. Women who possess a good balance of diverse skill sets and adaptable to change will thrive in future careers.

Additional areas for research include defining information technology skill sets from male technologists. It is also recommended to do a comparative study between skill sets and attitudes of technology professionals and methods for acquiring diverse skills.

CONCLUSION

Women technologists have adapted, and will continue to adapt, their skill sets to organizational change and industry shifts. Successful women technologists first specialize, then constantly diversify their skill sets to enhance employability. The most responsive woman technologists in today's organizations must truly possess skills beyond their technical training.

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KEY TERMS

Data Dictionary: Establishes a clear and unambiguous vocabulary for bookkeeping and documentation purposes. This may consist of precise definitions of data elements in order for forms and databases to be constructed.

Information Map: Can be any diagram, from a simple graphic to a complex software model, depicting corporate information.

Knowledge Management: To manage institutional intelligence as they would any other precious asset. It defined how well an organization develops its people and their capabilities to make a profit.

Knowledge Worker: A person with certain amounts of specialized training, based on prior, sound basic education.

Mentoring: To facilitate, guide, encourage continuous innovation, learning and growth to prepare the business for the future

Scope Creep: Describes the phenomenon in which the features are added or changed after the specification is finalized so they increase the time required to deliver the product.

User Interface: The object used to interact between a human and a physical device. It is a set of commands or menus through which a user communicates with a program.

S

The Social Construction of Australian Women in IT

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INTRODUCTION

The declining participation of women in IT education and professional work is now a well-documented research area (Adam, Howcroft, & Richardson, 2004), but the causes and remedies remain puzzling and complex. Studies have indicated that there are signs of the "shrinking pipeline" (Camp, 1997) even in the years between junior and senior high school (i.e., Meredyth, Russell, Blackwood, & Thomas, 1999) when girls' interest and confidence in the use of computers declines markedly.

A lack of clarity as to what constitutes the IT industry and the rapid rate of change complicate attempts to understand the reasons for the declining participation of women in the IT industry, as well as the declining interest in IT degrees. This is despite the fact that IT salaries compare well with other professional salaries and are superior to most traditional female occupations (Megalogenis, 2003). Our research also demonstrates that many people—especially women—enter the IT workforce via other qualifications indicating that traditional IT education is not very successful in attracting either the quantity or quality of students required to meet workforce needs. Furthermore, IT has not matched the rise in female participation in the traditionally male-dominated professions of science, engineering, and medicine.

AUSTRALIAN SITUATION

By the start of the last decade, the proportion of females in the IT workforce was beginning to decline in most western countries including Australia (von Hellens, Pringle, Nielsen, & Greenhill, 2000).

About 20% of the members of the Australian Computing Society are women. The Australian Bureau of Statistics show that the percentage of women working in IT occupations decreased in 1996-2001 despite the total number of people (men and women) with IT qualifications increasing significantly, to around 70% (Byrne & Staehr, 2003). IT education suffered one of the highest drop-offs in students' numbers between 2003 and 2004 and the IT schools' downturn has continued in 2005 (O'Keefe, 2005). Figures from the Australian Department of Education, Science, and Training reveal a 6.7% drop in IT, from the 68,271 students (domestic and overseas) in 2003 to 63,651 in 2004. The decline was even higher with women: a 14.7% decrease. The percentage of female students in IT declined from 24.02% to 21.97%. The information systems area of IT in the business schools has traditionally had more female students than the core IT programs. However, the downturn of students and female students in particular is apparent there too (Business/Higher Education Round Table, 2004).

WOMEN IN INFORMATION TECHNOLOGY PROJECT

To deal with this complexity, the Women in Information Technology (WinIT) research project has taken several perspectives, reflecting the multidimensional nature of the problem (von Hellens & Nielsen 2001; Trauth, Nielsen, & von Hellens, 2003). The project has surveyed and interviewed male and female high school students as well as undergraduate and postgraduate IT students. Interviews have also been carried out with high school teachers, vocational guidance counselors, IT academics, and professionals in the IT industry. A complete list of published research can be found at http://www.cit.gu.edu.au/~jenine/WinITProject/. This article provides an overview of the WinIT research and the findings to date.

The perspective taken in the WinIT research is based on widespread views of gender in IT:

- **"Sameness":** That women are capable of entering and succeeding in male domains by adapting to those domains.
- **Social Construction:** That in order to understand IT as a field of education and work, it is worthwhile to view it in terms of its social and political construction, in the same way that "female" domains such as child care and nursing may also be viewed.

Although the WinIT focus has been on female's perception, male students have also been interviewed and surveyed to further clarify the female experience. We have also focused on Confucian Heritage (CH) students from a range of South-East Asian countries who represent a major non-English speaking background ethnic group among IT students in the Australian education system including high school and universities, especially their female contingent.

HIGH SCHOOL STUDENTS

Male and female high school students in the IT entry-level mathematics course were surveyed and interviewed (Nielsen, von Hellens, Pringle, & Greenhill, 1999). Both Asian and non-Asian females had similar views about the work of an IT professional, who they characterized as a person working alone with a computer and thus not requiring any communication or people skills. Females perceived computing as boring, requiring logic or mathematics skills, and involving little contact with other people. There was a strong impression that women preferred different types of work that would require personal contact and communication. Female students expected boys to be more interested in computers than girls, as computing was perceived to be a masculine pastime. There was a false perception among female students that the participation of women in IT was improving rather than declining.

The use of computers outside school was equal between Asian and non-Asian girls, but Asian females were more inclined to choose computing and IT subjects at school, despite the presence of negative perceptions. It appeared that the usefulness of computing and the favorable prospects for employment, rather than personal interest, were stronger motivating factors for Asian students than for other female students.

FIRST YEAR UNIVERSITY STUDENTS

Research revealed that the IT degree was much harder than expected, and female students were either ignored or harassed (Nielsen et al., 1999). Males dominated the study environment physically. Although not all female students perceived this as a problem, some expressed resentment at other female students' reliance on male students and also of bad behaviour by male students in computer labs. Condescending behavior towards female students took the form of stereotyping based on intellectual achievement and physical appearance. Inclusion in the "pretty and smart female" group meant a privileged acceptance into the male-dominated setting.

There was a notable difference in the way Asian and non-Asian female students experienced gender-based discrimination. The former felt their opinions were not valued as highly as those of non-Asian students and all non-Asian people largely ignored them. As a result, they felt isolated and ignored and had to band together for guidance and assistance. On the other hand, non-Asian female students felt they were the focus for sexual harassment (e.g., via remarks and uninvited e-mails). They received unwanted positive discrimination in the form of easier marks, which was offensive to their sense of achievement. There were subtle differences in staff behavior towards female students, particularly if they were Asian. Interviewees claimed that lecturers preferred male students. Competition between students did not worry female students. Their social interactions were comfortable and they found it easy to initiate collaborations, however there was some confusion about the differences between working together, and plagiarism.

It was found that information about the IT degree programs was inadequate and poorly distributed. Teachers in high schools had provided misleading information about IT programs at university. Students were unclear about the skills required in the IT industry and what job opportunities the degree would provide. The Asian female students, in particular, were pessimistic about future job prospects. The reasons for choosing IT education were often arbitrary, including inability to qualify for a preferred course of study.

There was an overall perception of the IT course as difficult and demanding, and all students expressed reliance on networks for troubleshooting, group study, and support. Elements of racism and sexism operated against successful group work. Students in the university avoided working with other students due to racially defined differences, such as language, assuming it would result in a disadvantage for oral group presentations.

The applications of IT education were perceived and valued differently by the Asian and non-Asian females. Whereas the non-Asian females considered computing as having limited career options, the Asian females emphasized further career opportunities from IT education, although this did not necessarily indicate a better understanding of the IT industry. Asian girls experienced pressure from home to pursue IT and were aware of a family responsibility to provide for elderly parents.

Although many students valued IT as providing "flexible" work arrangements, not many students were sure what was meant by "flexible"; in terms of location, time, amount of work or wider job opportunities. Younger students with lack of work experience seemed confused about IT jobs in general. Mature-aged students with more experience in the workforce were able to acknowledge both the advantages and disadvantages of job flexibility.

CULTURE AND GENDER INFLUENCES

Existing research on perceptions of IT job in Asian and Westerns countries informed our research on high school and university students (Burn, Ma, & Ng Tye, 1995: Couger, 1996; Hofstede, 1980, 1994; Igbaria & McClosky, 1996). The conceptualization of the factors of culture and gender affecting students' perception of IT careers (Figure 1) summarizes our findings. This model (discussed in detail in Nielsen et al., 1999) attempts to display how factors of culture, gender and life history shape the students' perceptions of IT and suggests a categorisation of students according to why Computing and IT skills are valued. The extreme cases are students who value computing and IT skills for escapism for leisure and study at one end of the spectrum and those who prefer collaborative practices at the other end of the spectrum. The categories in the middle are those who value computing and IT skills for flexible work arrangements and those who value computing and IT skills in order to secure employment and to achieve an occupation of status. The model suggests that combining these two sets of values allows for a broader perception of IT (as social systems technically implemented).

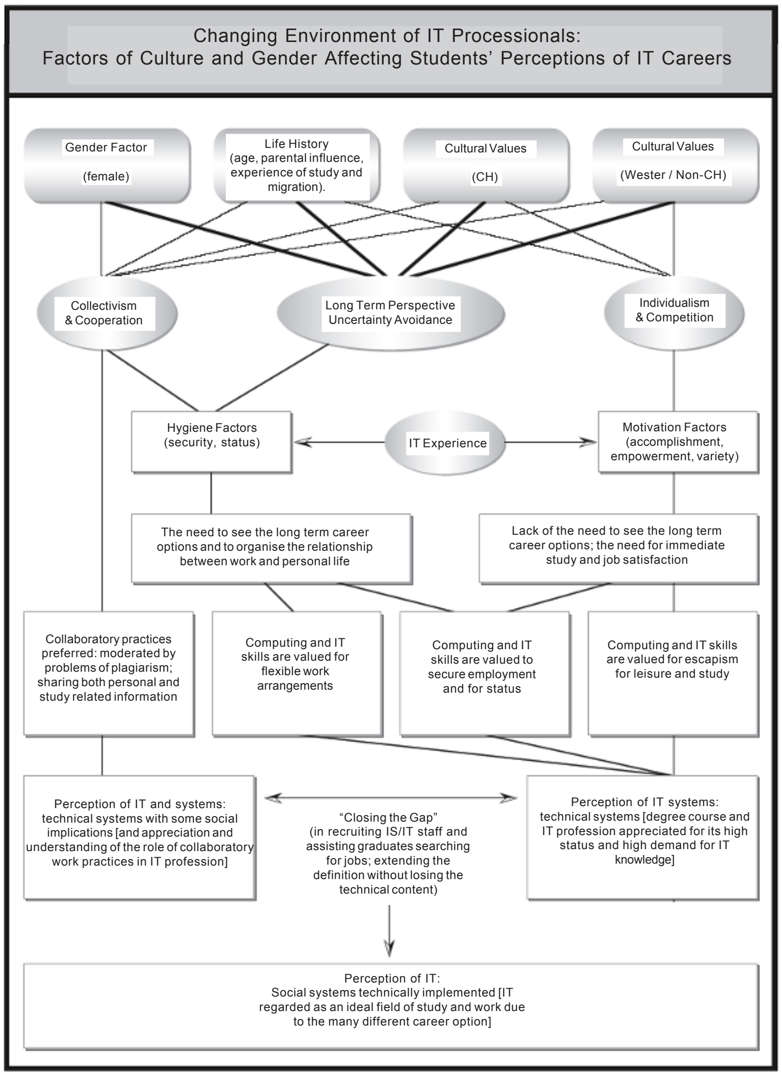
Our research also suggests students did not fully understand the new organizational forms that create, and are created by, IT innovations. Also, IT educators may not be conveying these changes and their relevance very effectively. First-year students were surprised at the amount of mathematics and programming required, especially as it seemed to contradict their experience of what was expected in the real world. Most students seemed to have a very narrow view of IT and were more concerned with understanding about computers, rather than the tasks to be supported by technology and the changing context in which IT is used. The conceptual model illustrates the changing environment of IT professionals.

Most females reinforced the expectation that females and males have equal ability, although some females believed men were smarter and better at the sort of study required for IT.

RESEARCH AMONG WOMEN IT PROFESSIONALS

Our research among female IT professionals examines the perceptions of women in the IT industry as expressed in their discourse about IT work. The research data was collected primarily through in-

Figure 1.



terviews with female IT Professionals, and a small number of male IT Professionals to further understand the declining female participation in IT education and work (von Hellens & Nielsen, 2001).

Our interest is in identifying patterns in women's discourse about IT work, which both reinforce and challenge the institutional discourse. Especially evident are discursive patterns in relation to skills required in the IT industry. There is a very large body of literature on the demand for IT skills, however our research differs from the primarily positivist approach taken in IT skills research. For example, Todd, McKeen, and Gallupe (1995) reported that the skills that are required from IT professionals are business, technical and systems skills. We have adopted Giddens' view (1984, 1991) and challenge the strictly objective/subjective approach to the formation and maintenance of institutions. From a structuration theory point of view, demand for IT skills cannot be treated as a matter of social fact, but is implicated in the structuration of the IT industry, and reinforced or challenged by industry participants.

The female IT professionals saw themselves as task oriented, client focused, and hard working. They also emphasized the importance on mentoring and parental support and the element of chance that triggered their entry into the IT industry. They did

Table 1. Dualisms of skills in IT work.

Dualisms of skills in IT work
Home/work
IT industry/career certainty
IT work/emotion
Intuition/analysis
Programmer/people focused
Soft skills/technical education
Solving problems/talking to people
Technology/business problems
Technical/management
Technical/people skills
Technology/communication skills

not view their gender as making a difference, although successful women adopted ways of working that were not common to women, in order to adapt to different IT environments.

These perceptions and their representations may not have a straightforward relationship to the types of categorisations (business/technical, etc) made by studies of IT skills (Nielsen, von Hellens, & Beekhuyzen, 2004). In order to examine this relationship we use the notion of "dualisms"—which represent IT works and skills as a set of either or propositions (see Table 1)

One of the most interesting dualisms is the separation of soft and hard skills, not only in terms of their association with women and men, but also in terms of how they are learned and valued. This is expressed by one interviewee as follows: "Skills like communication and organisational ... they're things that you can train into yourself from a little child—your parents can help you with those. But things like technical skills like IT would need … you will only get that at a tertiary institution."

The women viewed themselves as being able to switch between "male" and "female" skills, such as "people" and "technical skills" but challenged the conventional wisdom that women have superior communication and organizational skills (von Hellens et al., 2000). The interview data showed a number of examples of gender specific dualisms, as listed in Table 2.

One interviewee commented why political skills are perceived as uncommon among women "I think one of the key skills for large corporate organisations is the networking skills and if I use the term 'office politics' I mean that's a more negative term but its understanding the culture of the organisation, what do you need to do, who do you need to talk to. Women traditionally I think are not good at talking about what they do and how they do it and their success."

Our findings among women IT professionals are not very different from other professions where also the importance of mentors and encouragement is emphasized, as well as the chance factor, being in the right place at the right time. Traditional wisdom argues that women are valued for their "female" skills in the IT industry. However, the contradictions in the discourse show skills attributed to gender are difficult to define, and that it is not clear why some women are attracted to and successful in the IT industry.

FUTURE TRENDS

Countries like Australia face unpredictable shortages of qualified IT personnel. The IT industry is one of fastest growing, with more than 2.5 times the average growth of the Australian economy as a whole (Business/Higher Education Round Table, 2004), but interest in IT education is declining, particularly amongst women. Strategies to improve the gender balance and to make IT education more appealing to adolescents are not uniformly successful and the situation has not improved.

Table 2. Gender specific dualisms in IT work

Issue	Men	Women
Attention to detail	Uncommon	Common
Broad perspective	Uncommon	Common
Continuous learning and rapid change	Common	Uncommon
Assertiveness	Common	Uncommon
Communication	Uncommon	Common
Noisy vocalism	Common	Uncommon
Political skills	Common	Uncommon
Networking	Common	Uncommon
Left brain	Common	Uncommon
Programming	Common	Uncommon
Technical skills	Common	Uncommon

Low female participation in IT education and work is a complex social problem, reflecting general confusion about the identity of the IT industry itself. More research is required to understand how this identity is constructed. Ongoing research on how female identities and gender differences in IT work are constructed (Anthias, 1999; Nielsen et al., 2004) will assist in clarifying the identity of the IT industry. To extend the use of Giddens' structuration theory beyond what has been done in the WinIT research to date is recommended, including work practice observations and the examination of documentation.

CONCLUSION

The WinIT research has taken a social construction view of female participation in the IT industry, assuming that social institutions are constructed by as well as constraining the activities of their participants, and that unhelpful constructions may be deconstructed and rebuilt. The IT industry was earlier perceived as a "level playing ground," a new industry which would offer broad participation to all interested parties. Many of the institutions deriving from the IT industry, such as the Internet, have had a liberalizing influence. However, to date, the IT industry appears to be constructed as a masculinised domain, unattractive to most women and many men. Considering its importance to modern society, this construction of the IT industry needs to be challenged so that all stakeholders can participate in the design as well as the utilization of IT products and services.

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KEY TERMS

Asian: In our study "Asian" is not defined categorically, but refers to a range of East and South-East Asian Confucian-heritage (CH) culture, which represent a major non-English speaking background ethnic group among IT students in Australian.

Confucian-Heritage (CH) Culture: CH refers to a range of East and South-East Asian Confucian-heritage (CH) cultures, including Singapore, Hong Kong, Taiwan, PRC and to some extent Vietnam, Korea, Japan, emphasizing self-control, adherence to social hierarchy and social and political order. CH culture provides a background against which personal life histories can be considered.

High School: Also called Secondary School; grades 7 or 8 to 12. Students must attend school in Queensland, Australia until 14 and 9 months (usually Grade 10). Students may choose to continue into senior secondary school, Grades 11 and 12, and specialize in their choice of subjects. Completion of year 12 is usually required for entry to university degree programmes.

Information Technology Education: The IT degree programmes referred to in this article are undergraduate Australian university degrees, commonly called the Bachelor of Information Technology (BIT). They are professionally accredited and provide core IT education.

Information Technology Field: The technical and people oriented area of information technology development and utilisation in organisations and in society. Information technology education provides core technical skills for the analysis, design, development and use of computer-based information systems.

Private School: Independent school that receives only a small amount of government funding.

Public School: Government funded school.

Social Construction of Gender and Sexuality in Online HIV/AIDS Information

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INTRODUCTION

HIV (human immunodeficiency virus) and AIDS (acquired immunodeficiency syndrome) represent a growing and significant health threat to women worldwide. According to the United Nations (UNAIDS/WHO, 2004), women now make up nearly half of all people living with HIV worldwide. In the United States, although males still accounted for 73% of all AIDS cases diagnosed in 2003, there is a marked increase in HIV and AIDS diagnoses among females. The estimated number of AIDS cases increased 15% among females and 1% among males from 1999 through 2003 (Centers for Disease Control and Prevention, 2003). Looking closer at HIV and AIDS infections among women in the United States, Anderson and Smith (2004) report that HIV infection was the leading cause of death in 2001 for African-American women aged 25 to 34 years, and was among the four leading causes of death for African-American women aged 20 to 24 and 35 to 44 years, as well as Hispanic women aged 35 to 44 years. The rate of AIDS diagnoses for African-American women (50.2 out of 100,000 women) was approximately 25 times the rate for white women (2 out of 100,000) and 4 times the rate for Hispanic women (12.4 out of 100,000; Centers for Disease Control and Prevention). African-American and Hispanic women together represented about 25% of all U.S. women (U.S. Census Bureau, 2000), yet they account for 83% of AIDS diagnoses reported in 2003 (Centers for Disease Control and Prevention).

Women's vulnerability to HIV and AIDS may be attributed to gender inequalities in socioeconomic status, stereotypes of AIDS as a gay-male disease, and cultural ideology around sexual practices such as abstinence, monogamy, and condom use. Because of cultural mores and socioeconomic disadvantages, women may consequently have less access to prevention and care resources. Information is perhaps the most important HIV and AIDS resource for women, and the Internet provides a useful platform for disseminating information to a large cross-section of women. With the flourishing use of e-health resources and the growing number of public-access Internet sites, more and more people are using the Internet to obtain health-care information. Over two thirds of Americans (67%) are now online (Internet World Statistics, 2005). On a typical day, about 6 million Americans go online for medical advice. This exceeds the number of Americans who actually visit health professionals (Fox & Rainie, 2002). Studies also show that women are more likely to seek health information online than are men (Fox & Fallows, 2003; Fox & Rainie, 2000; Hern, Weitkamp, Hillard, Trigg, & Guard, 1998). HIV and AIDS patients are among the health-care consumers with chronic medical conditions who increasingly take the Internet as a major source of information (Kalichman, Weinhardt, Benotsch, & Cherry, 2002).

As more Americans go online for health information, the actual efficacy of the information consumption becomes salient. Recent digital divide studies call for shifting from demographic statistics around technological access to socially informed research on effective use of technology (Gurstein, 2003; Hacker & Mason, 2003; Kvasny & Truex, 2001; Payton, 2003; Warschauer, 2002). Although the Internet provides a health information dissemination platform that is continuous, free, and largely anonymous, we should not assume that broader access and use will be translated into positive benefits. We must begin to critically examine the extent to which e-health content meets the needs of an increasingly diverse population of Internet users.

To combat the AIDS pandemic, it is necessary to deliver information that is timely, credible, and multisectoral. It has to reach not just clinicians and scientists, but also behavioral specialists, policy makers, donors, activists, and industry leaders. It must also be accessible to affected individuals and communities (Garbus, Peiperl, & Chatani, 2002). Accessibility for affected individuals and communities would necessitate targeted, culturally salient, and unbiased information. This is a huge challenge. For instance, health providers' insensitivity and biases toward women have been documented in the critical investigation of TV programs (Myrick, 1999; Raheim, 1996) and printed materials (Charlesworth, 2003). There is a lack of empirical evidence to demonstrate the extent to which and the conditions by which these biases are reproduced on the Internet. In what follows, we provide a conceptual framework for uncovering implicit gender biases in HIV and AIDS information. This framework is informed by the role of power in shaping the social construction of gender and sexuality. We conclude by describing how the framework can be applied in the analysis of online HIV and AIDS information resources.

BACKGROUND

Gupta (2000) has explored the determining role of power in gender and sexuality. Gender, according to Gupta, concerns expectations and norms of appropriate male and female behaviors, characteristics, and roles shared within a society. It is a social and cultural construct that differentiates women from men and defines the ways they interact with each other. Distinct from gender yet intimately linked to it, sexuality is the social construction of a biological drive, including whom to have sex with, in what ways, why, under what circumstances, and with what outcomes. Sexuality is influenced by rules, both explicit and implicit, imposed by the social definition of gender, age, economic status, ethnicity, and so forth (Dixon Mueller, 1993; Zeidenstein & Moore, 1996).

What is fundamental to both sexuality and gender is power. The unequal power balance in gender relations that favors men translates into an unequal power balance in heterosexual interactions. Male pleasure supersedes female pleasure, and men have greater control than women over when, where, and how sex takes place (Gavey, McPhillips, & Doherty, 2001). Therefore, gender and sexuality must be understood as constructed by a complex interplay of social, cultural, and economic forces that determine the distribution of power. As far as HIV and AIDS, "the imbalance in power between women and men in gender and sexual relations curtails women's sexual autonomy and expands male sexual freedom, thereby increasing women's and men's risk and vulnerability to HIV" (Gupta, 2000, p. 2; Heise & Elias, 1995; Weiss & Gupta, 1998).

Based on this feminist approach to theorizing gender and sexuality, Gupta (2000) categorized HIV and AIDS programs in terms of the degree to which historical power dynamics in gender and sexuality were maintained. The categories summarized in Table 1 are depicted in Figure 1 ranging from the most damaging to the most beneficial ones.

In the theory of social construction, HIV and AIDS are represented as a set of social, economic, and political discourses that are transmitted by media (Cullen, 1998). In symbolic interactionism's theory of gender, mediated messages in advertising, TV, movies, and books tell quite directly how gender is enacted (Ritzer, 1996). As the latest platform for computer-mediated communication, the Internet may also adhere to these gendered representations. We theorize that online HIV and AIDS information follows a similar pattern of power reconstruction, and that these categories could be applied to empirically determine how and why online HIV and AIDS information reproduces these power relations.

FUTURE TRENDS

This theoretical framework could be employed in empirical studies that deconstruct online materials to demonstrate how HIV and AIDS gain their social meanings at the intersection of discourses about gender and sexuality. Prior studies in this area have focused on the cultural analyses of AIDS (Cheng, 2005; Sontag, 1990; Treichler, 1999; Waldby, 1996) rather than structural determinants of risk such as political policy, globalization, industrialization, and

Table 1. Categories of HIV and AIDS programs based on gender and sexuality

Category	Description
Stereotypical	The damaging stereotypes of men are reinforced with terms like "predator, violent, irresponsible," and the role of women is given as "powerless victims" or "repositories of infection" (Gupta, 2000, p. 5).
Neutral	The target is the general population instead of either gender or sex. Despite there being no harm done and the data being better than nothing, the different needs of women and men are ignored. Very often the basis is research that only has been tested on men or works better for men.
Sensitive	The different needs and constraints of individuals based on their gender and sexuality are recognized and responded to. One example is in the provision of female condoms. Thus, women's access to protection, treatment, or care can be improved, but little is done to change the old paradigm of imbalanced gender power.
Transformational	The aim is to transform gender relations to make them equitable. The major focus is on the redefinition of gender roles at the personal, relationship, community, and societal levels.
Empowering	The central idea is to "seek to empower women or free women and men from the impact of destructive gender and sexual norms" (Gupta, 2000, p. 6). Women are encouraged to take necessary actions at personal as well as community levels to participate in decision making. One misunderstanding that needs to be corrected is that empowering women is not equal to disempowering men. The fact is more power to women would eventually lead to more power to both since empowering women improves households, communities, and entire nations.

Figure 1. Continuum of the social construction of gender and sexuality

the economy. Cultural analysis is based upon the belief that this disease operates as an epidemic of signification based on largely predetermined sexual and gendered conventions. The female has now become socially constructed as a body under siege in AIDS discourse. This gendered body is not, however, a stable signifier. Previously, the body was constructed as white, gay, and male. Now the global discourses on HIV and AIDS have constructed the body as third world, heterosexual, and female. Thus, we see a feminization of HIV and AIDS.

Analysis of the social construction of AIDS using this framework could occur at different levels of analysis and with various populations. We conclude with a few examples.

- Garbus et al. (2002) provide a categorization of HIV and AIDS Web sites that could be used for a cross-category or within-category analysis of the representation of gender and sexuality.
- Cultural ideologies around condom use for AIDS prevention and reproductive health could be studied.
- Given the wide disparities in HIV and AIDS infections among women in the United States, research is needed to examine the discursive practices surrounding HIV and AIDS, socio-economic status, geographic region, and ethnicity or race.
- The absence of lesbians in the HIV-AIDS and women discourse can be analyzed.
- The social construction of the female body in the HIV and AIDS discourse can be studied.
- Discursive practices surrounding HIV and AIDS, gender, and development in developing countries are a potential research subject.
- The tension in the social construction of women as both vulnerable receivers and immoral transmitters of this deadly disease can be deconstructed.

CONCLUSION

HIV and AIDS are a complex and pressing issue. It is not just an issue of health, but has also been framed as an issue of personal responsibility, economics, development, and gender equity. It impacts every nation and individual across the globe. In this article, we argue that the increasing epidemic of HIV and AIDS among women is also an issue of information. We propose a framework for unpacking discursive practices that construct women as the new face of HIV and AIDS. We also provide examples of problem domains in which the feminist analysis informed by this framework can be conducted.

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KEY TERMS

Digital Divide: Unequal access to and use of computers and the Internet resulting from such socioeconomic gaps as income, education, race, and age.

E-Health: The applications of the Internet and global networking technologies to medicine and public health.

Empowerment Theory: The study of how perceptions of power affect behaviors and how individuals can increase their power through social interaction.

Feminist Theory: Women-centered theory that treats women as the central subjects, seeks to see the world from the points of women in the social world, and seeks to produce a better world for women.

Gender: Expectations and norms of appropriate male and female behaviors, characteristics, roles, and ways of interaction that are shared within a society.

Sexuality: Social construction of a biological drive, including whom to have sex with, in what ways, why, under what circumstances, and with what outcomes.

Social Construction of Information: Information is examined not as objective missives, but rather as data inextricably intertwined with the social settings in which they are encountered.

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The Social Impact of Gender and Games

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INTRODUCTION

An increasingly important area of gender and information technology is that of Internet, computer, and video games. Besides women increasingly playing conventional entertainment-oriented or role-playing games, there are a number of pertinent developments in gaming. They are adver-games, casual games, games for change or "serious" games, and games aimed at women and/or developed by women.

Computer and video games are a significant area of interest for a number of reasons. In the United States, games generate substantially more annual revenue than motion picture exhibition, totalling over $11 billion for three consecutive years from 2002 to 2004 (Hollywood Game Daemon, 2004; Traiman, 2005). Research by the Entertainment Software Association indicates that:

half of all Americans play computer and video games, with women making up the second largest (demographic) group of gamers. Games are steadily becoming a dominant way that people spend their leisure time, often stealing time away from traditional media, like television. (Games for change mentioned at NYC Council Hearing, 2005)

In addition, games often reinforce traditional gender roles (Cassells & Jenkins, 2000) and reproduce negative racial and ethnic stereotypes, even as male players comfortably assume female identities (Baker, 2002). As greater numbers of consumers spend time gaming, the advertising industry has taken notice and is following the population into the game world with advertising. The game enthusiasts comprise a desirable target, freely spending on games and other products. Gamers spend an estimated $700 a year per capita on games (Gamers are spending 700 dollars a year, 2005).

CONTROVERSIAL ASPECTS OF ENTERTAINMENT-ORIENTED GAMES

While many games are designed to entertain players involve team and individual sports, car racing, and life simulators such as "Sim City" and "The Sims" do not fundamentally disturb the guardians of public morality. "The Sims" and "Sims 2" permit players to guide simulated beings through their daily lives in cyberspace (Surette, 2005). Another segment that has traditionally attracted the attention of the majority of players is marked by violence and sexual stereotypes. The impact of this category of game has stimulated such controversy that laws have been passed to ban the sale of games depicting violence against law enforcement officials, and guidelines governing game sales to minors have been imposed by retailers (Carlson, 2005; Morris, 2003; Muir, 2004). At least one study indicates that exposure to violent video games even leads to increased short term aggressive behavior in young women (Anderson & Murphy, 2003). Another study, an online survey, tested the hypothesis that an aggressive personality is attracted to aggressive video games, and that women are less likely to play computer games because they are socialized to be less aggressive. Women who used the computer but did not play games and women gamers were subjects of the survey. Women who played computer games perceived their online environments as "less friendly but experienced less sexual harassment online, were more aggressive themselves, and did not differ in gender identity, degree of sex role stereotyping, or acceptance of sexual violence" (Norris, 2004) when compared against the non-gaming women.

Many IT professionals trace their interests in the field to their childhood exposure to games (Kaji, 2002). Gorski (2001) finds this link unfortunate given that most entertainment-oriented games depict women as "damsels in distress or sideshow prostitutes."

More than half of girls and women do not find in games a hospitable environment and, thus, miss an early opportunity to enter the computer science education and career pipeline enjoyed by their male counterparts. A game blogger site reported that an IT manager's game recently released by Intel had to be withdrawn because it did not give players the option to hire women (Water Cooler Games, 2004).

WOMEN'S USE OF CONVENTIONAL COMPUTER AND VIDEO GAMES

In a very real sense, a kind of gender "digital divide" has tended to exist in the gaming environment. Specifically, the rift between boys and girls begins to widen as early as kindergarten (Agosto, 2004). The action-orientation of hard-core gaming has favored boys, male adolescents, and young men. However, this situation has begun to change. Despite the often unwelcoming environment historically posed by the gamescape, many girls and women are increasingly drawn to a number of games. ABC News (2005) recently reported that women enjoy video games for the same reasons men do—for excitement and competition. The report went on to cite video game experts who credited a single game title, "The Sims," for helping to change the gaming industry "virtually overnight." Earning $3 billion last year, half of the game's players are women.

Other gender issues in computer and video games have to do with marketing and content. The Women's Game Conference scheduled for October 2005 includes the site and process of women's purchase of games and the message—"marketing can hurt as well as help." Girls learn early that games are marketed and designed for boys. A number of studies indicate that games are perceived as "boys' toys" and "the disconnect between many computer games available today and girls' game content and design preferences" (Agosto, 2004). Another topic planned for the conference is the representation of women in ads. The literature indicates that the portrayal of characters in games can influence girls' interest in games. Most of the characters are male, and female characters are portrayed negatively. Content issues planned include the importance of art for female players and female entertainment criteria (Women's Game Conference, 2005).

CASUAL GAMES AND GENDER

BBC News recently reported that a research firm found that while hardcore online gaming continues to be dominated by young men, "bored housewives" are stimulating the growth of other game categories available on the Internet (BBC News, 2004). Female players constitute two thirds of the growing market in such skill games as cards, solitaire, and puzzles. This segment is termed casual games.

In contrast to hard-core gamers, casual gamers are classified as those who have played online games within the last three months (Twist, 2005). Even though men spend more time on the Internet each week than women (23.2 vs. 21.6 hours), female gamers over 40 spend the greatest time per week playing online games (9.1 hours or 41% of their online time vs. 6.1 hours—26% of their online time—for men).

In order to serve this growing market, women are being recruited to create games attractive to women. Women gamers are viewed as intelligent players who like a challenge and strategy (ABC News, 2005). At the same time, the future of growth in video gaming depends on the development of easier user interfaces. One of the key players in Canadian digital entertainment is Ana Serrano, director of Habitat New Media Lab, the interactive think tank at the Canadian Film Centre (Seguin, 2005). Among her responsibilities is growing the video game industry.

THE GAMES FOR CHANGE OR SERIOUS GAMES MOVEMENT AND GENDER

The games for change or "serious" game movement consists of video and computer games being used as tools for social change rather than as mere entertainment. The serious games initiative "focuses on uses for games in exploring management and leadership challenges facing the public sector" (Muir, 2005, p. 4). Further, the initiative seeks to link the electronic game industry and projects relating to the use of games in education, training, health, and public policy. The Web site for Social Impact Games carries a quote from Will Wright, Designer of "Sim City" and "The Sims" that notes that "Many game designers today are looking to maximize the social impact of their work." (Social Impact Games*,* 2005)

The Social Impact of Games site lists a number of game categories. They range from public policy and political games to education and learning games to health and wellness games. One job learning title is set in a simulated high-tech company where students learn job skills as part of a training course. A particularly salient topic is food security. The World Hunger—Food Force game addresses world hunger and targets young people. The United Nations World Food program establishes a presence in the gamescape, where a major crisis has developed in the Indian Ocean. Clearly, this undertaking could attract girls or adolescents who want to use computers and/or IT to solve a simulated real world problem.

At the opposite end of the spectrum another, decidedly more commercial game category includes the adver-game, that is, a type of game with a promotional or advertising purpose. The United States Army has developed such an adver-game to brand the particular service branch and to attract recruits into the service (Oser, 2005). Other marketers have followed the Army's lead. One of them is DaimlerChrysler with its Race the Pros Games for Dodge and another Coca-Cola Company's NCAA Championship Run.

THE FUTURE OF SERIOUS GAMES AND GENDER

The increase in advertising in video games played online will parallel the rise in adver-games. In 2004, $280 million was spent on advertising in games. By 2008, that amount will increase to $1.05 billion. While the serious games movement will not be completely buoyed by swelling advertising dollars, the rise in such spending may well sustain the trend of more women as players and as designers of computer and video games. Cell phones, MP3 players, PDAs, set-top boxes, children's toys, and even exercise equipment are among the expanding number of platforms for games (Seguin, 2005). Cell phones are proliferating in the hands of men and women alike, so the movement of games to mobile phones may provide an impetus to further progress in the diversity of the gaming industry. While mobile phone gaming may be plagued in the short run by relatively slower response times (Roman, 2005), the rise of this platform is certainly likely to enable playing of skill games by women casual gamers.

The issue of equity in information technology careers may be addressed as more girls are exposed to a more diversified gaming environment. With casual, serious/games for change, and even adver-games offsetting the traditional hard-core, more girls and women may play games and enter the computer science pipeline. The advantage of serious games is that the sector addresses the oft-expressed interest of girls and young women in using IT not as an end in itself, but as a tool to resolve actual real-world problems. As the slogan of the Water Cooler Games states, it is a "site about video games with an agenda." This phrase should appeal to girls and young women developing their own agendas in education, advocacy, and even advertising.

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KEY TERMS

Adver-Games: Games designed and published for specific advertisers, including the U.S. Army and Coca-Cola.

Branding: The application of a name, term, symbol, design, or a combination of all of these to differentiating a firm's product from another.

Casual Games: Online skill games such as solitaire played by gamers within the last three months.

Digital Divide: The condition of unequal access to computer-related resources, varying along the demographic dimensions of age, gender, race and ethnicity, education, income, and nationality.

Diversity: In a social and cultural context, the presence in a population of a wide variety of cultures, opinions, ethnic groups, socio-economic backgrounds, disabilities, and sexual preferences.

Equity: The process of achieving fairness among women and men while the term "gender equality" speaks to equality in status and equal enjoyment of fundamental human rights.

Gender: The sex of a person or organism, or of a whole category of people or organisms.

Serious Games: Computer and/or video games with a primary purpose other than entertainment.

Strategies of ICT Use for Women's Economic Empowerment[1]

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INTRODUCTION

Information and communication technologies (ICT) provide a great development opportunity by contributing to information dissemination, providing an array of communication capabilities, and increasing access to technology and knowledge, among others. Access to and the cost of ICT continue to be a major development obstacle, particularly in the developing world. Despite the growth in mobile telephony, peri-urban[2] and rural areas—home to a great majority of women and poor populations—continue to lack infrastructure and ICT services in general. For ICT to become meaningful development tools, ICT policy and programs must address the needs of women and the poor in general. This article discusses the main challenges and obstacles faced by women, suggests practical strategies to address those challenges and provides recommendations on how to proceed to improve the conditions leading to women's economic empowerment.

CHALLENGES OF ICT USE FOR WOMEN'S ECONOMIC EMPOWERMENT

Just as in many other areas of development (e.g., agriculture, health, and education), women face enormous challenges to use ICT for their own economic empowerment. Using and benefiting from ICT requires learning, training, affordable access to the technology, information relevant to the user and a great amount of support (to create enabling environments). The challenges are many and they fall in a few categories. The following is a discussion of some of these challenges and how they hinder ICT use for women's economic empowerment.

Affordable Access and Availability of Infrastructure

Access to affordable services and availability of infrastructure is, without a doubt, a major requirement if ICT are to be used for women's economic empowerment. While this discussion focuses on access to telecommunications and ICT infrastructure, it is important to note that other infrastructure and service-related factors may influence the use of ICT, such as availability of electricity, transportation means and security, among others.

Access to Telecommunications Infrastructure

Telecommunications infrastructure is limited in most developing countries and costs are exceedingly high. Whatever little infrastructure is available is concentrated in the larger urban areas, and services provided are only affordable to a few. Bandwidth costs as well as transmission costs incurred by Internet Service Providers (ISP) are high and passed on to users. In rural areas, where women make up the majority of the population, infrastructure is almost non-existent, and services are generally too expensive to poor populations.

The rapid expansion of wireless technologies as well as decreasing costs provide great opportunities in rural areas and areas with little or no infrastructure. For example, in the Dominican Republic, fixed wireless public telephones (using satellite technology) were installed in rural areas without service. These telephones, operated using phone cards, not only provided the community with greatly needed telephone service, but also provided rural women with an additional source of income, as many sell the phone cards that they buy in bulk from the telephone company.

Figure 1.

Grameen Phones, Bangladesh Evidence shows that when provided with access and business opportunity, women have become owners and frequent users of cellular telephone services. The Grameen Phones program in Bangladesh, which sets Village Phone Operators to resell wireless telephone services, is an example of an initiative that has contributed greatly to women's economic empowerment and has increased cellular telephone use by women tremendously. In fact, "where women are operators, 82% of the users were women; with men operators, women comprised only 6.3% of Grameen phone users." (Hafkin & Taggard, 2001).

Access to ICT

Access to ICT is highly dependent on telecommunications infrastructure, particularly if one is focusing on telephone service, faxes, e-mail and the Internet. However, the use of ICT is not only based on these services. Radio, for example, provides a great source of information dissemination in many areas of the world, and so does television. Where available, computers may be used as a source of information and a tool for training without the use of telecommunications. The use of CD-ROMs, such as in the case of the IDRC-IWTC CD-ROM for illiterate women in Uganda, *Rural Women in Africa: Ideas for Earning Money* (both in English and Luganda), illustrate that ICT can be used in creative ways and in ways that are more effective and affordable than other solutions (such as browsing or obtaining the information via the Internet) (Mijunbi, 2002).

Radio and television, as the widest form of communication, provide one-way solutions for information dissemination. Women's radio clubs are increasing in Africa, Latin America and the Caribbean, and provide a means to share information on development issues. Recent projects show that radio can be used well beyond a listening-only device, and effectively become a successful two-way communication tool.

In Zimbabwe, some 52 women's radio listening clubs are active in the Development Through Radio (DTR) project, aiming at giving rural women access to radio through participation in production of programmes based on their development needs and priorities. Information exchange is a significant part of the programmes. Women pose questions and an information intermediary puts the question to a concerned official. The response becomes part of the weekly broadcast. (Hafkin & Odame, 2002, p. 28)

Access to ICT is crucial if they are to be used as a means for women's economic empowerment, and no community should be left short-changed simply because of a few alternatives. The challenge here is that we need to work towards universal access to ICT while actively devising creative solutions to provide alternative access to information to those who need it the most and can immediately benefit from the exchange of information, increased knowledge and diminished isolation.

Cost of Access and Lack of Affordable Solutions

Even when infrastructure is available, affordable access is a concern in most developing countries. Pricing regulation within a privatized and competitive environment (as is the case for most telecommunications operators) has not proven successful in ensuring universal and affordable access. Universal-access policies aim at developing solutions that provide community access at affordable prices, including expansion of public telephones and ICT access points (e.g., in post offices, community centers).

Lack of Gender Awareness in Telecommunications and ICT Policy

Telecommunications and ICT policy lack a gender focus in most countries of the world. With a few exceptions (e.g., South Africa, Korea), there is no emphasis on gender-specific projects or any attempt at ensuring that policies reflect gender equality goals. There are no positive discrimination efforts in place to improve women's access to ICT, increase women's participation in decision-making or project-management positions. Policies that increase women's participation in decision-making and policy-making positions or that, for example, ensure a proportion of funds to be allocated to women's ventures, women's organizations or organizations with a strong gender focus, can contribute to increase use of ICT by women and, consequently, contribute to economic empowerment (Jorge, 2001).

Social, Cultural, and Economic Factors

This discussion focuses on some of the most important social, cultural and economic factors that challenge the use of ICT for women's economic empowerment.

Language and Content Limitations

Lack of local and community-related content as well as content in local languages continue to be a major barrier in women's use of ICT for economic empowerment. Multimedia tools are essential, as they can be developed to provide information both in spoken and written languages. The challenge is to develop content that is relevant and useful to communities in their own language.

Education and Skills

With a great percentage of illiterate women and many speaking local and regional languages, ICT face tremendous challenge to be effectively used by these communities. Again, recent experiences show that it is possible to address these issues (such as the CD-ROM projects in Uganda), and ICT advocates and policy-makers should focus on developing programs that address the development needs and demands of these communities in ways that they can benefit from it. Particularly, it is important to involve community women in the process of deciding what kind of projects will be most useful.

ICT require that users have some skills, and no one should assume that by providing the facilities, everyone in the community will immediately embrace the technology. There are two important aspects here. First, as Eva Rathgeber clearly stated, "The key issue is that the technologies should be adapted to suit women rather than that women should be asked to adapt to suit the technology" (Marcelle, 2002). And second, ICT training is critical if women are to use the technology of choice. Gaining the required skills not only allows women to feel comfortable as ICT users but further empowers women to use ICT in many other ways, such as, for example, increasing their employment choices and their contribution to community development. In Ecuador, where BarrioNet and Chasquinet established telecenters in peri-urban areas of Quito, women are using ICT and the telecenter facilities to assist them in community-organizing efforts, effectively communicating with government officials on issues to improve their community's environment and improving their small business activities.[3]

Addressing Women in the Informal Sector

Women in developing countries are primarily active in the informal economy as handicraft makers, street vendors and so forth. Most of these women are poor and could potentially benefit from ICT in a number of ways. The challenge will continue to be one of reaching women in this sector and consequently providing them with ICT tools that they feel can make a difference in their income generation potential. For example, there are a few organizations (e.g., Development Workshop, ADRA and OMA) working with women in the informal markets in Luanda, Angola; however, with women's lack of time and daily pressure to make ends meet, it is difficult to bring them to resource centers and organize training sessions of any kind. The well-known Self Employed Women's Association (SEWA) in India has done extensive work to assist women in informal markets and has recently established an ICT program aiming to increase efficiency of rural micro-enterprise activities.

PRACTICAL STRATEGIES OF ICT USE FOR WOMEN'S ECONOMIC EMPOWERMENT

Understanding the challenges allows us to better address the problems at stake and devise strategies to consider the complex dimensions of women's lives. Extremely interesting work in this area has been done recently by Nancy Hafkin and Nancy Taggard, who documented the many opportunities for women's economic empowerment through IT use (Hafkin & Taggard, 2001). This discussion identifies some practical strategies that can facilitate women's use of ICT in ways that truly empower women and contribute to their development.

- **Providing Community Access to ICT:** Community access to ICT addresses two of the greatest challenges in ICT use: lack of access and cost of access. Community access can be provided in numerous ways, such as with phone shops, telecenters (with different models for different settings), public phones and libraries, among others, and in strategic locations (e.g., near or at the informal market area, adjacent to health clinics or support organizations, at women's organizations, etc.). Community access can be affordable and based on dependable technology solutions (e.g., wireless and fixed wireless and satellite connections) that can rapidly be installed and effectively utilized. Policies may include, among other things, community access tariffs, subsidized tariffs for areas with extremely low incomes and special incentives for companies that invest in rural areas.[4]

  It is important to view ICT as a tool to meet women's development needs and priorities, and as such, all forms of ICT should be considered to determine which is more appropriate in a particular setting and for the particular program. Despite the fact that the Internet may provide more comprehensive information on a particular topic, it may very well be that a radio program or video produced in the local language will be more effective in the short run in disseminating requested information for women in a rural area. These types of solutions may be accompanied by discussion groups, where women can exchange ideas and share concerns. There is a responsibility to make technology work for the people and, in many cases, that requires a gradual transformation in the use of ICT themselves. For example, women in the informal sector may decide that cellular telephones are all that they need to improve their businesses, but may become more interested in the use of the Internet for business purposes once their businesses grow and as they feel more comfortable using technology.
- **Be Familiar with and Take Advantage of Telecommunications Development Funds (TDF) and Other Universal Access Policies:** There is a great disconnect between universal access policies and resources and the many ICT projects being implemented throughout the developing world. TDF are established and administered by telecommunications regulators to finance the expansion of universal access to ICT in underserved and rural areas. Funds are distributed based on the quality and cost of the proposed projects. Most TDF are established to finance ICT access projects, including telecenters, phone shops, public telephones and libraries. TDF have been successfully developed and implemented in many Latin American countries (e.g., Peru and Chile) and several countries in Africa and Asia are currently working towards developing their own TDF (e.g., Zambia, Uganda, Nigeria, Sri Lanka).
- **Advocate for and Develop Government-Funded Training Programs:** As in all areas of technology use and innovation, training is a crucial factor to ensure that a country is prepared to utilize the technology and increase productivity. Training programs should be offered free of charge or, in fact, be considered a "job," in that participants are paid a certain salary as an incentive to participate and increase their education and qualification level.
- **Develop Special-Interest Content in Local Languages:** Content in local languages is extremely important if ICT are to make a difference in women's lives. In fact, development of content that address priority issues of a particular community may be a major incentive for the use of ICT and to increase community interest in learning more about ICT use for economic empowerment. It is, therefore, extremely important to develop content that addresses local/regional/national needs, to provide information relevant to local/regional/national issues and consequently disseminate the information in appropriate languages. These efforts should be coordinated and supported by those involved in each particular area of interest. For instance, the government and ministry of health of a specific country may have already developed guidelines regarding disease prevention for each region of the country, but lack the capability to properly disseminate the information, particularly in remote rural areas. ICT access points can become major venues for dissemination of public health information

and, as a result, introduce women and men to the use of ICT. Some organizations working on health issues may also qualify as hosts for ICT access points and, as a result, become effective users of ICT to improve their own work and consequently the health of the population in their region.

- **Gender-Aware Participatory Methods to Assess the ICT Needs and Demands of Women:** There are numerous potential uses and areas where ICT could contribute to poverty reduction and improved economic opportunities. However, it is important to realize that one woman's use of ICT may be completely irrelevant for another woman in a different setting. Again, the point is to ensure that ICT can meet women's needs rather then having women adjust to ICT (Marcelle, 2002).

  Gender and ICT advocates and practitioners must engage in gender-aware participatory methods to assess the needs of women and develop a clear understanding of how ICT can best be used as a tool for women's economic empowerment. As a result, we can develop creative solutions that use ICT to provide programs that promote and facilitate the use of ICT. Using the example of women in the informal sector, it is important to allow women to choose the technology they feel most comfortable with, such as a cellular telephone to call for market prices, even if it may not be the most efficient solution (when the local NGO may provide daily up-to-date price information at no charge).

WHERE DO WE GO FROM HERE?

With access and cost being some of the greatest barriers for ICT use, it is of the utmost importance to engage women and gender advocates in the policy-making process and dialog. Advocates must make an effort to familiarize themselves with the various aspects of ICT policy and understand the gender dimension of these aspects. It is important to engender ICT policy to ensure that women, particularly rural and poor women, benefit from ICT. And gender and ICT advocates are responsible to inform the ICT debate on gender issues and to ensure that gender analysis becomes an integral part of the policy process. The work done by gender and ICT advocates throughout the WSIS has been critical and reflects some of these lessons. The same is true with respect to ICT project analysis and design. If we want to address gender with ICT projects, gender must be considered from the start of project design (Hafkin & Jorge, 2002). Only then can ICT policy and projects properly address the gender digital divide and further contribute to women's economic empowerment.

It is essential to engage the ITU and other U.N. agencies and programs involved in ICT work in more active training of policy makers and ICT advocates on gender analysis. ITU frequently conducts training seminars and workshops for regulators and policy makers of member states. These training activities should incorporate gender considerations and gender analysis in their plans. In addition, each country's ministry of women affairs or equivalent agency should be involved in the process to mainstream gender among government organizations and should develop specific gender training programs to educate policy makers on gender issues and gender analysis.

As an outcome of WSIS and within the context of the MDGs, the U.N. and all its partners must make a special effort to develop and use gender-disaggregated data and indicators at all levels of ICT development (i.e., from national ICT use to ICT program indicators). This will establish a baseline of information that will be essential to monitor and evaluate access to ICT and the impact of ICT use for women's economic empowerment.

Last, but not least, steps must be taken to ensure that there is greater participation and access to the policy process and to information resulting from policy decision. It is frustrating to see that, even where there are policies and programs in place to improve access (e.g., TDF), few women's organizations or organizations working towards gender equality benefit from the programs. There is no reason for these organizations not to receive funds to establish ICT access points or even to implement telecenter-type programs. These sort of initiatives would certainly contribute to women's economic empowerment.

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WWW RESOURCES AND SITES CONSULTED

- www.barrioNet.org
- www.chasquinet.org
- www.dw.angonet.org
- www.genderit.org
- www.sewa.org
- www.un.org/womenwatch/daw/egm/ict2002/documents.html
- www.whrnet.org/icts/aisgwg_intro.html
- www.worldbank.org/gender/digitaldivide/digitaldivide20.htm

KEY TERMS

Community Access Centers or Telecenter: Generally refers to a community-owned and -operated initiative with the goal of providing affordable access to ICT and ICT-related services relevant to the specific community it serves (including locally relevant content in local language, a focus on the preferred technology, etc.).

Gender: Gender refers to culturally and socially constructed roles and behaviors of women and men, and identifies the social relations between women and men. It is distinct from the biological differences between women and men.

Gender Analysis: It involves the systematic research and analysis of information based on gender differences and relations, in order to address inequalities and work towards gender equality.

Information and Communication Technologies (ICT): New ICT generally refer to telecommunications technologies (i.e., telephone, fixed and mobile; fax; radio; TV; satellite), computer technology (i.e., to process data) and networking technologies (i.e., the Internet, voice-over Internet platforms, etc.).

Universal Access to ICT: The ability of any individual, regardless of location (geographical), income, gender, race, age, language and so forth, to access ICT at a shared community access point at a reasonable distance (which can be defined by walking distance, number of meters, kilometers or miles) from his or her household. The concept of universal access also encompasses the notion of affordable access (i.e., a price community members can pay).

Women's Empowerment: Refers to the ability to make choices and shape one's environment based on those choices (which can be different in different contexts, societies and cultures). Empowered women are able to challenge and define their environments at all levels of their lives, as individuals, as workers, as mothers, as daughters and so forth.

ENDNOTES

1 Adapted from an earlier paper by the author: Jorge, S. (2002). The economics of ICT: Challenges and practical strategies of ICT use for women's economic empowerment, prepared for the UN-DAW expert group meeting on information and communications technologies and their impact on and use as an instrument for the advancement and empowerment of women, Seoul, Korea. (http://www.un.org/womenwatch/daw/egm/ict2002/documents.html)

2 Peri-urban areas are those areas in the periphery of major cities and where poor populations tend to settle when they migrate closer to urban centers. Peri-urban areas often include large shanty-towns or illegal settlements with little or no infrastructure and high rates of poverty.

3 See www.barrioNet.org and www.chasquinet.org

4 For a detailed discussion of such policies, see Jorge, Sonia, "Gender Sensitive ICT Policy: Rethinking Policy Making," comprehensive training workshop, prepared for the Workshop on Equal Access of Women to ICT, Seoul, Korea, October 2001; Marcelle, Gillian, "Getting Gender into African ICT Policy: A Strategic View," in Eva Rathgeber and Edith Ofwona Adera, *Gender and the Information Revolution in Africa*, IDRC, 2000; and African Information Society-Gender Working Group, "Engendering ICT policy: guidelines for action," Johannesburg, 1999. www.whrnet.org/icts/aisgwg_intro.html

Student and Faculty Choices that Widen the Experience Gap

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INTRODUCTION

A major teaching challenge for higher education faculty is students' wide differences with respect to experience or knowledge with the subject matter or skill set of a class. In computing education research, this is often referred to as the "experience gap." Research shows that the experience gap contributes to the low participation of women in professional information technology (IT) careers. Women are significantly more likely to enter college-level IT courses with little or no computer programming experience than are their male peers (College Board, 2004). Yet, programming experience is positively associated with success, especially in introductory classes (Taylor & Mounfield, 1994; Bunderson & Christensen, 1995; Brown, 1997; Margolis & Fisher, 2002), and low grades are positively associated with attrition from the major (Strenta, Rogers, Russell, Matier, & Scott, 1994). When women receive low grades due to inexperience, they may be more likely than males to lose confidence and leave the major (Cohoon & Aspray, in press).

Another type of experience gap becomes evident in cross-disciplinary teams, where students encounter others whose areas of expertise and knowledge are substantially different, often to the point where students have difficulty understanding each other. According to IEEE Computer Society/ACM Computing Curricula Task force, "Computing education is also affected by changes in the cultural and sociological context in which it occurs" (IEEE and ACM Joint Task Force, 2001, p. 10). For this reason, both Computing Curricula 1991 and 2001 strongly recommend the integration of experiences and opportunities for student understanding of real-world applications and the people who need them. Courses that provide opportunities for collaborative and interdisciplinary learning are also often recommended to increase retention of women in science, technology, engineering and mathematics (STEM) courses in general (Agogino & Linn, 1992; Felder, Felder, Mauney, Hamrin, & Dietz, 1995) and in computing, in particular (McDowell, Werner, Bullock, & Fernald, 2003; Barker, Garvin-Doxas, & Roberts, 2005). Yet, collaborative learning and, in particular, project-based courses, must be carefully planned and managed for students to have similar learning outcomes. In this article, we demonstrate how students' choices can reinforce and even widen differences in experience and reduce their ability to develop cross-disciplinary understandings.

BACKGROUND

Unlike most assignments in the computer science curriculum, team projects are too complex to be completed by a single student. Team projects involve building practical solutions to substantial problems, requiring that students evaluate alternative designs in terms of cost, performance and so forth. Team members must determine what they will deliver and how—and how to distribute the work. The process of bringing idea to product is part of what gives students the professional experience.

In their review of projects within the traditional computer science curriculum, Fincher, Petre and Clark (2001) characterize project work as a way for students to "show their stuff." To be successful in project work, they note, students must demonstrate mastery of a diverse collection of technical skills acquired over terms or years of study. The authors believe that the most diverse project teams are formed by splitting up "affinity groups" (friendships or cultural groups) and creating a mix of interpersonal and technical abilities. Such teams may increase the potential for peer learning. Teams formed from computer science majors from a single institution, however, are quite likely limited in their diversity of knowledge and may not bring students professional experience in interacting with people substantially different from themselves.

More innovative IT programs present the possibility of more heterogeneous project teams with students of different majors. Ideally, the tasks performed by such groups require that all students share their knowledge and expertise as well as their questions and uncertainties in ways that lead to peer learning (Tinzmann, Jones, Fennimore, Bakker, Fine, & Pierce, 1990). However, this ideal assumes that students take equal responsibility for the roles of teacher and student, and that tasks focus on learning through dialog and hands-on activities (Johnson & Johnson, 1994). Knowledge asymmetry, when one group member is more expert on a topic than another, is to be encouraged and expected in group projects because it creates an opportunity for peer tutoring, benefiting both the more expert and less expert students. Further, in successful learning groups, students alternate between different types of roles and communication: those involving peer tutoring in which the roles of "teacher" and "student" are clear and well defined, and collaborative sequences where students work together in free discussion to create knowledge and understanding with no clear role differences (Haller, Gallagher, Weldon & Felder, 2000).

Yet, simply putting students in project groups does not automatically lead to improved or cross-disciplinary learning through the processes described above, because students' understanding of collaboration may be quite limited by lack of experience and even a belief that collaboration is cheating (Barker, Garvin-Doxas, & Jackson, 2002). Instead, they often divide the work, taking on the part most consistent with their "comfort zone" or most expedient for finishing the project. When students have different levels or areas of knowledge, students of both sexes can take on gendered roles or roles based on experience. Further, students may accept less learning in the interest of getting a product and "showing their stuff." The case study we present below demonstrates how students take on roles in project groups.

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WIDENING THE EXPERIENCE GAP

This case study describes one project team from Technology for Community (T for C), an undergraduate computer science course taught at the University of Colorado at Boulder. In T for C, student teams work with local community service agencies, building computational solutions to problems confronting those agencies. The course has no prerequisites, and participants have diverse backgrounds in terms of educational experience, major and expertise with technology. Although few computer science majors are female, this course has consistently attracted a large proportion of female students. Most of those women, however, come from the technology, arts and media (TAM) certificate program.

The TAM certificate program, open to all undergraduates, requires that students take six courses, three of which require hands-on development in project teams. Students acquire expertise with high-end software packages (e.g., Flash, Photoshop) and some HTML programming, with the goal of designing and producing multimedia materials both for self-expression and to serve clients. Programming courses (e.g., Java) are optional, and most students do not take them. Three of the courses are focused on historical issues related to information and communication technologies, communication theory, implications of media for society and the like. TAM student enrollment is consistently more than half women.

In each T for C project, students are expected to acquire new skills and experience. While most students improve their abilities to interact with a real client with real needs and to design for and test with real users, not all succeed in enhancing their technical skills. Instead, students, succumbing to real or imagined time constraints, fall into their comfort zones. Because of the multidisciplinary nature of the course, students arrive with different levels of technical, communication and design experience. Learning to work across disciplines within project teams is a new experience for many of the students, and different project teams succeed to different degrees in responding to that diversity. The case study below illustrates how one student team responds to both types of experience gap.

The case is based on data collected in an ethnographic study conducted by the first author. Ethnography is a qualitative research method that focuses on articulating the shared—yet often unspoken—rules, beliefs and values produced and made visible in everyday communicative interaction. The second author developed the T for C course and has taught it for four semesters. The case study is based on 35 hours of observation of T for C, a focus group interview with 10 TAM students (including both of the females presented below) and experiences of the instructor.

On one T for C team, Jane (studying TAM, Spanish and education), Maria (studying TAM, journalism and molecular biology) and John (studying computer science) were tasked with creating an educational Web site for middle school children in a bilingual charter school. They attended a workshop including the school principal, conducted interviews with her and visited the school to understand teachers' and children's needs. Building the site required design and content development and HTML coding. Once the parameters of the project were defined, the students decided which of them would carry out which tasks. They then began their work on those tasks, individually or jointly.

All three students were bright, creative and accomplished in their chosen majors, yet early in the project, the differences in those majors led to a severe breakdown in their interactions. The two women complained to the instructor that John was uncommunicative, not available to meet and a poor contributor. The instructor was surprised: She knew John from two previous courses to be conscientious, friendly and well liked by peers. She nonetheless called John in for a discussion about his work in T for C. As it turned out, John was unaware of the dissatisfaction of his teammates. He was working hard on his parts of the project and checking in with Maria and Jane regularly by e-mail. The conflict turned out to be a problem of culture. John was accustomed to solitary, late-night work in the computer lab while the women were expecting regular, in-person project team meetings. The instructor intervened, making John aware of the need for such meetings while letting Jane and Maria know that the meetings would have to take place late in the day to accommodate John's work schedule. With those simple ground rules in place, the students quickly found common ground in their project, and they came to see that everyone was making good contributions. For the remainder of the semester, theirs was a very successful project team, and lasting friendships among the three resulted.

While Maria, Jane and John ultimately developed a high-quality site for the school, a closer look at their interactions revealed some troubling features with respect to the experience gap. In particular, the students split up the work along disciplinary (perhaps gendered) lines, with Jane and Maria making most design and content decisions, and John doing the HTML coding. It is easy to see why Jane, as a Spanish major and pre-service teacher, would be especially good at providing content for this project. However, John's and Maria's roles were not quite so straightforward and were negotiated through many interactions. For example, at one point, the three were discussing icons and images. As Maria explained to John at length why she saw an image as particularly good, he repeatedly expressed agreement with her, but she did not acknowledge it. It was as if she could not register that he might possibly know enough about images to agree. On another occasion, the team was having a technical problem saving an image as a GIF file. Jane's opinion overrode John's suggestion for solving the problem on the implied basis that she had a better eye for image quality; his solution, she said, would diminish that quality. Maria's view of John's potential contributions to the project was limited, and limiting to John.

Yet John was clearly conscious of design and thoughtful about content and users' needs. For example, when deciding on the approach to helping children find the help they need with research, the purpose of the site, it was his idea to use questions ("Do you want to find a book?") rather than headings ("Research"), because as he said, "kids don't think in those terms." During whole-class discussion about intuitive tasks, John pointed out that in the Macintosh interface, dragging the floppy disk icon to the trashcan to eject can make people afraid that they're somehow deleting files on the disk. In fact, throughout the project, we documented many of John's insightful comments about the site's appearance and content. But with his ideas and knowledge repeatedly ignored or brushed aside, John learned implicitly that design and content were not to be his domain. Jane and Maria seemed to have staked out content and design as their territory. This move may appear to be gendered, yet it was also made by virtue of their unarticulated beliefs about what kinds contributions a computer science major can make.

During the focus group interview, TAM students discussed the image of a computer science major. Maria said, "I've taken a C++ programming class and there's really no creativity there." It is not clear whether Jane shared this belief (several other students objected to this), but Maria's inability to see computer science as "creative" may have impeded her ability to "hear" John's design ideas. Her initial beliefs and the implicit messages embedded in many interactions were likely a factor in John's relegation to HTML coding—at the expense of his obvious desire to participate in design decisions. Also interesting is the revelation that although Maria adopted the role of content and design, she actually had substantial programming experience. When we asked Maria why she and Jane did mainly content and design and John the coding, she narrowly characterized John's contribution, explaining that he was a fast programmer, that she and Jane had made a similar Web site before and that they were under time pressure (more on this later). In spite of her own ability to function in any of the three roles, Maria was unable to see John, a CS major, as functional in the roles of content and design. In fact, all three of those students could have provided more input or support in all three knowledge domains.

T for C is intended as a long-term projects course where students may enroll for several semesters, continuing work on very large-scale projects. Nonetheless, students usually feel pressured to finish their projects within a one-semester time frame. At the end of the semester, when we asked Maria why John mainly coded while she and Jane did content and design, she cited John's speed and the women's prior experience with such a site, adding, "it's just the way the class was set up." Asked what she meant by the class being "set up" that way, she said, "Because of the time pressure. We had to get it all done." Her perception was at odds with the professor's beliefs and observation data about the structure of the courses; that is, students were told explicitly that they did not have to finish projects to earn a grade, but that learning was more important.

FUTURE TRENDS

Many of the behaviors described in the case study were also displayed by other T for C project teams. Students chose or were subtly assigned roles based on their perceptions of experience and apparent beliefs about what kinds of people should make what kinds of contributions. The ways students conceptualize teamwork and the potential contributions of team members have a profound effect on their ability to extend their skills and knowledge beyond what they already know. What students already know is influenced by years of gendered choices, with female students being more likely to have design experience and male students more likely to have programming experience.

When students are allowed to select their roles based on expediency or comfort, it works against the benefits of collaborative and cross-disciplinary learning. While this approach may seem practical and efficient, it does not provide any of the students with a new learning experience, but instead practice of existing skills. Thus, those with less experience fall into this trap, missing out on the opportunity to advance their experience and knowledge about software development and, as a result, continue to remain behind. At the same time, students like John, with technical experience, lose the opportunity to work on skills that they do not already possess, such as client relation skills and content and design.

Without overt and explicit measures implemented and enforced by instructors, other pressures, such as perceived time constraints, a tendency to allow group members to focus on what they already know how to do well, and gendered and disciplinary beliefs about what is appropriate for people of different categories to contribute to a project, male and female students alike can miss out on the opportunity to add to their skills and will instead complete their projects using skills they have already mastered. The multi-disciplinary understanding that comes from having worked in another knowledge domain is a desired, but not acquired, learning gain.

CONCLUSION

Both men and women are gendered beings, imposing their beliefs about appropriate behavior for men and women on themselves and on others. The literature on women in IT often portrays women as powerless, passive victims of a male-oriented curriculum within a male-dominated academic culture. This case demonstrates that both men and women can be the agents of oppression, imposing their expectations for behavior on each other and themselves in ways that preclude full participation in a project. Research into gender issues in IT must take into account that both women and men are gendered beings who make gendered choices if we are going to have a better understanding of how to bring to parity the male-female composition of the IT workforce. Instructors must also make pedagogical choices to impose and enforce learning objectives as part of group assignments. If all students are assessed for particular learning outcomes, the experience gap is less likely to widen.

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KEY TERMS

Attrition: When students switch out of a major area of study.

Collaborative Learning: When students work together to learn new material. It contrasts with individual learning, where a student learns without talking to or working with other students.

Cultural and Sociological Context: Specific types of social situations; the ways people behave in social situations are influenced by the cultures, societies, institutions and so forth in which they occur.

Experience Gap: In education, the difference among students in a class in prior knowledge and experience with a subject or activity.

Gender: A set of social categories that shapes how males and females behave and the ways that others treat them based on deeply ingrained expectations about how males and females *should* respond. In contrast, sex describes biological categories.

Positive Association: A situation where when one element increases, another increases. This does not mean one causes the other, just that they co-occur.

Project-Based Courses: Courses in which students, working individually or in groups, undertake an activity that goes on over a period of time. The outcome is a product, presentation or performance.

Survey Feedback Interventions in IT Workplaces[1]

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INTRODUCTION

Several factors may explain the underrepresentation of women in IT. One reason is the portrayal of the IT workplace as hostile, or at least inhospitable, to women. Long work hours, a frenetic pace, and few family-friendly benefits are believed to characterize many IT work environments (Howard, 1995; Lambeth, 1996; Panteli, Stack, & Ramsay, 1999). Another reason is the perception that IT careers afford little social interaction or support (Misic & Graf, 1999). The stereotype of the IT worker as a "geek" who works in isolation from others may be less appealing to women than men (Spender, 1997). Moreover, white males are most frequently portrayed as IT professionals in the media, are most likely to have role models and support systems, and work in work environments that reflect their values and learning styles (Balcita, Carver, & Soffa, 2002). Subtle biases in stereotyping and language use and working in a white male culture may contribute to feelings of exclusion for women. Finally, male IT supervisors may be less likely to develop supportive relationships with women than men (Ragins, 2002), thereby reducing their bond to the organization and leading to their eventual dissatisfaction and departure from IT work and the organizations that employ them (Lee, 2004).

Our research examines how characteristics of the IT workplace can foster inclusion and equal opportunity for IT employees (see Major, Davis, Sanchez-Hucles, Germano, & Mann, 2006). We are particularly interested in identifying barriers and enablers to the career success of women and minorities in IT departments. During Phase 1 of this three-year project, IT departments completed a Web-based survey designed to understand the factors that shape the access that IT employees have to opportunities in the workplace. During Phase 2 of the project, we provided the IT departments with feedback from our survey, conducted focus groups and structured supervisor interviews, and worked with the organizations to identify and implement changes designed to increase opportunity and inclusion for IT employees. During Phase 3 of this project, we administered another survey to assess the effectiveness of the interventions implemented during Phase 2. The remainder of this chapter describes our sample, survey measures, and research methodology.

BACKGROUND

During Phase 1 of our project, 916 IT employees from 11 companies completed our Web-based survey. Participating organizations varied in terms of industry, size, and location, in order to more broadly represent the diversity of IT work experiences and workplace climates. See Table 1 for a detailed description of participants.

Survey Measures

The measures used in the Web-based survey are described in Table 2.

Inclusion

The 13-item inclusion scale was created from existing measures and original items (Chrobot-Mason & Aramovich, 2002; Mor-Barak & Cherin, 1998). Inclusion was assessed using three subscales: belonging, participation, and influence. An example of an item from the belonging subscale is, "I am included as part of the team by my coworkers." A sample

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Table 1. Demographic characteristics of the total sample, N = 916

Characteristic	N	% of Total Sample
Gender		
▪ Males	530	57.9
▪ Females	344	37.5
▪ Gender not specified	42	4.6
Race		
▪ American Indian or Alaska Native	27	2.9
▪ Asian (non-Indian)	47	5.1
▪ Asian Indian	35	3.8
▪ Black or African American	74	8.1
▪ Hispanic	51	5.6
▪ Native Hawaiian or other Pacific Islander	8	0.9
▪ White	617	67.4
▪ Multiple Race	5	0.5
▪ Race not specified	52	5.7
Relationship Status		
▪ Single	140	15.3
▪ Married	639	69.8
▪ Living with Partner	22	2.4
▪ Separated	11	1.2
▪ Divorced	59	6.4
▪ Widowed	4	0.4
▪ Did not specify	41	4.5
Educational Attainment		
▪ High school graduate	71	7.8
▪ Vocational/technical school graduate	59	6.4
▪ Associate's degree	115	12.6
▪ Bachelor's degree	472	51.5
▪ Master's degree	144	15.7
▪ Doctorate degree	6	0.7
▪ Did not specify	49	5.3
IT Degree		
▪ IT related	405	44.2
▪ Non-IT related	404	44.1
▪ Did not specify	107	11.7
IT Position		
▪ Conceptualizer	288	31.4
▪ Developer	169	18.5
▪ Modifier/Extender	80	8.7
▪ Supporter/Tender	302	33.0
▪ Did not specify	77	8.4
Salary ($)		
▪ Less than 30,000	21	2.3
▪ 30,000 - 39,000	46	5.0
▪ 40,000 - 49,000	93	10.2
▪ 50,000 - 59,000	133	14.5
▪ 60,000 - 69,000	119	13.0
▪ 70,000 - 79,000	124	13.5
▪ 80,000 - 89,000	85	9.3
▪ 90,000 - 99,000	86	9.4
▪ 100,000 or more	140	15.3
▪ Did not specify	69	7.5
Characteristic	**Mean**	**Standard Deviation**
Number of Children	1.11	1.13
Age of Youngest Child	11.08	6.29
Age of Participant	41.98	8.90
Years Worked at Current Organization	10.44	8.51
Years Worked in IT	14.44	8.67
Hours Worked per Week	46.69	7.96

Table 2. Description of survey measures

Measure	Source	# Items	Coefficient Alpha
Inclusion:			
▪ Belonging	Chrobot-Mason & Aramovich (2002)*	5	.94
▪ Participation	Mor-Barak & Cherin (1998) *	4	.93
▪ Influence	Mor-Barak & Cherin (1998) *	4	.90
Climate for Opportunity	Mor-Barak, Cherin, & Berkman (1998)	6	.88
Workplace Relationships:			
▪ Affective Coworker Support	Ducharme & Martin (2000)	5	.92
▪ Instrumental Coworker Support	Ducharme & Martin (2000)	5	.92
▪ Leader-Member Exchange	Graen, Novak, & Sommerkamp (1982)	7	.92
▪ Satisfaction with Mentoring	Ragins & Cotton (1999)	4	.84
Satisfaction:	Hackman & Oldham (1975)*		
▪ Overall Job Satisfaction		16	.91
▪ Satisfaction with Supervision		3	.92
▪ Satisfaction with Job Security		2	.88
▪ Satisfaction with Pay		3	.84
▪ Satisfaction with Social Environment		3	.74
▪ Satisfaction with Growth Opportunities		5	.85
Organizational Commitment	Mowday, Steers, & Porter (1979)*	9	.91
Career Commitment	Blau (1985)*	8	.86

*Note: *Indicates measure was adapted or supplemented with original items.*

item from the participation subscale is, "My judgment is respected by members of my workgroup." An example of an item from the influence subscale is, "I am able to influence decisions that affect my job." Participants used a five-point Likert-type scale anchored by 1 (*strongly disagree*) and 5 (*strongly agree*) to respond to all inclusion items. Coefficient alpha for the entire scale for the present sample is .94.

Climate for Opportunity

Climate for opportunity was assessed using six items developed by Mor-Barak, Cherin, and Berkman (1998) to tap organizational fairness. An example item is, "Managers here give feedback and evaluate employees fairly, regardless of the employee's ethnicity, gender, age, or social background." Participants responded to the items using a six-point Likert-type scale anchored by 1 (*strongly disagree*) and 6 (*strongly agree*). For the present sample, climate for opportunity yielded a coefficient alpha of .88.

Coworker Support

Coworker support was measured using a 10-item scale developed by Ducharme and Martin (2000). The measure assesses affective and instrumental support. Affective coworker support is a form of social support that coworkers offer by being sympathetic, listening to problems, and expressing care and concern. An example of an item tapping affective coworker support is, "Your coworkers take a personal interest in you." In the present sample, coefficient alpha for the affective coworker support items is .92. Instrumental coworker support is tangible helping behavior offered by coworkers in response to specific needs (e.g., assistance with work responsibilities and switching schedules). An example of an item that assesses instrumental coworker support is, "Your coworkers would fill in when you are absent." In the present sample, coefficient alpha for the instrumental coworker support items is .92. Participants responded to the coworker support items using a five-point Likert-type scale anchored by 1 (*strongly disagree*) and 5 (*strongly agree*).

Leader-Member Exchange

The quality of the relationships between IT employees and their supervisors was assessed using Graen, Novak, and Sommerkamp's (1982) seven-item measure of Leader-Member Exchange, the LMX 7. An example item is, "Regardless of how much formal authority he or she has built into his or her position, what are the chances that your leader would use his or her power to help you solve problems in your work?" The response scales for each item vary, but all are five-point Likert-type scales on which higher numbers indicate greater LMX. For the present sample, the LMX 7 yielded a coefficient alpha of .92.

Mentoring

First, IT employees were asked to indicate whether or not they currently had at least one mentor. For participants who indicated that they did have at least one mentor, they were asked to complete a four-item scale developed by Ragins and Cotton (1999) that assessed employees' satisfaction with their mentor(s). Participants responded to the satisfaction with mentoring questions using a five-point Likert-type scale anchored by 1 (*strongly disagree*) and 5 (*strongly agree*). An example of an item assessing satisfaction with mentoring is, "My mentor is someone I am satisfied with." The satisfaction with mentoring scale yielded a coefficient alpha of .84 for the present sample.

Job Satisfaction

Overall job satisfaction and multiple facets of job satisfaction were measured using 15 items adapted from Hackman and Oldham's (1975) Job Diagnostic Survey. The measure includes subscales that assess five facets of job satisfaction, including satisfaction with supervision, satisfaction with job security, satisfaction with pay, satisfaction with social environment, and satisfaction with growth opportunities. Participants responded to the job satisfaction items using a seven-point Likert-type scale anchored by 1 (*extremely dissatisfied*) and 7 (*extremely satisfied*). For the current sample, coefficient alpha for overall job satisfaction is .91. Coefficient alpha for the five subscales ranged from .74-.92 (see Table 2). A sample item for satisfaction with supervision is, "The amount of support and guidance I receive from my supervisor." An example of an item assessing satisfaction with job security is, "The amount of job security I have." The following sample item assesses satisfaction with pay, "The amount of pay I receive." A sample item for satisfaction with social environment is, "The chance to get to know other people while on the job." Lastly, an example of an item tapping satisfaction with growth opportunities is, "The amount of personal growth and development I get in doing my job."

Organizational Commitment

Mowday, Steers, and Porter's (1979) nine-item measure of organizational commitment was used to assess how loyal and attached a participant is to his or her employing organization. Participants used a seven-point Likert-type scale anchored by 1 (*strongly disagree*) and 7 (*strongly agree*) to respond to the nine items. A sample item is, "I am willing to put in a great deal of effort beyond that normally expected in order to help this organization be successful." This measure yielded a coefficient alpha of .91 for the current sample.

Career Commitment

An eight-item measure developed by Blau (1985) was adapted to assess career commitment. Career commitment describes one's attitudes towards one's profession or vocation. An example of an item is, "This is the ideal profession for my life's work." Participants were asked to respond to the career commitment items using a five-point Likert-type scale anchored by 1 (*strongly disagree*) and 5 (*strongly agree*). For the current sample, the career commitment measure yielded a coefficient alpha of .86.

Gender Differences

Phase 1 means for participants' age, number of children, years worked in IT, organizational tenure, and hours worked per week are broken down by

Table 3. Mean differences for men and women

Factor	Men N	Men M	Men SD	Women N	Women M	Women SD	df	t
Age	521	42.07	9.02	329	41.84	8.72	848	0.36
Number of Children	518	1.19	1.20	334	0.99	1.00	797.5	2.66*
Years Worked in IT	524	15.55	8.94	338	12.75	7.99	860	4.67*
Organizational Tenure	525	9.79	8.59	338	11.46	8.31	861	-2.81*
Hours Worked Per Week	525	47.52	7.88	338	45.42	7.95	861	3.81*

*Note. *p < .01.*

Table 4. Gender comparisons for race, relationship status, and salary

Characteristic	Percentage Men	Percentage Women	Gender Difference (Yes/No)
Race			No
▪ American Indian or Alaska Native	3.0	3.2	
▪ Asian (non-Indian)	5.1	5.8	
▪ Asian Indian	3.0	2.0	
▪ Black or African American	7.2	10.5	
▪ Hispanic	6.4	4.9	
▪ Native Hawaiian or other Pacific Islander	1.1	0.6	
▪ White	70.2	70.6	
▪ Multiple Race	0.4	0.9	
▪ Race not specified	1.3	1.5	
Relationship Status			Yes
▪ Married	79.7	68.9	
▪ Single	20.4	30.8	
▪ Did not specify	0.0	0.3	
Salary ($)			Yes
▪ Less than 30,000	1.1	4.4	
▪ 30,000 - 39,000	5.5	4.9	
▪ 40,000 - 49,000	10.4	11.0	
▪ 50,000 - 59,000	12.3	19.8	
▪ 60,000 - 69,000	13.2	14.0	
▪ 70,000 - 79,000	14.5	13.7	
▪ 80,000 - 89,000	10.0	9.3	
▪ 90,000 - 99,000	10.4	9.0	
▪ 100,000 or more	20.0	9.6	
▪ Did not specify	2.6	4.4	

Note: N = 530 for men. N = 344 for women. Married described respondents who indicated that they were married or living with a partner at the time of the study. Single described respondents who indicated that they were single, separated, divorced, or widowed at the time of the study.

gender in Table 3. There were significant gender differences on each of these variables, with the exception of age. Compared to women, men reported having more children, working in IT a greater number of years, having shorter organizational tenure, and working more hours per week. Gender comparisons were also made for race, relationship status, and salary, as shown in Table 4. There were statistically significant gender differences for relationship status and salary but not race. Women were disproportionately single, and men were disproportionately married. Generally, men reported higher salaries than women.

FUTURE TRENDS

Upon completion of Phase 1 of the research project, we analyzed the data collected from the Web-based survey and created reports for each organization as part of our survey feedback intervention. Phase 2 of the project began with the distribution of these feedback reports to participating organizations. The primary reports for each organization provided information regarding that company's standing on each of the constructs measured in the survey. In addition, each company was provided with benchmarking comparison data from the other participating companies. Thus, each company was able to see how it scored on each construct relative to the other companies in our project. When an organization's sample was sufficiently diverse, companies also were provided with information on any gender and/or ethnic differences in survey responses. Finally, each company also received work group level survey feedback reports for any group with at least five respondents reporting.

After the reports were disseminated to the leadership at a company, feedback meetings with company executives and feedback presentations to IT employees were given. In addition, we invited IT employees to participate in focus groups where a small group of people convened to discuss concepts and to address issues relating to the results from the survey. The aim of the focus group discussion was to obtain qualitative data to aid in interpretation of the survey results, clarify any ambiguities, and point out any related issues that were not addressed in the Web-based survey. Then, based on the survey findings and focus group feedback, we worked with management to develop action plans that capitalized on their strengths and addressed their weaknesses with regard to opportunity and inclusion for all employees. Our feedback has facilitated both managerial and organizational development. In addition to emphasizing the factors that make an IT work environment more inclusive, we have taken this opportunity to educate managers on how to view diversity as a strategic business value.

We are currently in Phase 3 of the project. Phase 3 involves resurveying participating organizations to assess the effectiveness of the interventions implemented during the second phase of the project. Like Phase 2, we will provide each organization with a feedback report detailing that company's standing on each of the constructs measured in the survey. The report also examines any changes in an organization's scores from the first survey to the second. When an organization's sample is sufficiently diverse, companies also receive information on any gender and/or ethnic differences in survey responses. When the Phase 3 data collection is complete, each company will again be provided with benchmarking comparison data from the other participating companies.

CONCLUSION

We believe that our focus on climate for opportunity and inclusion is not only applicable to the workplace, but is also relevant to educational environments in which IT professionals are trained (e.g., computer science). Based on our research findings, we propose that an inclusive learning environment is likely to be enhanced when students have supportive relationships with faculty members and peers. Enhancing the inclusiveness of learning environments would likely result in greater satisfaction with IT education, heightened commitment to the IT field, and greater likelihood of completing an IT-related degree, thus increasing the number of women IT graduates who enter the workforce. We describe elsewhere in this volume how inclusive educational environments might be created (see Davis, Major, et al.).

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KEY TERMS

Action Plan: Strategy that includes concrete steps to take in order to implement positive organization change.

Best Practices: Policies, procedures, philosophies, and practices employed by top performing IT supervisors that were revealed in structured interviews.

Climate: Consists of employees' perceptions of workplace events, practices, and procedures, including which behaviors are rewarded, supported and expected (Schneider, Wheeler, & Cox, 1992).

Focus Group: A small group of people convened to discuss concepts and to address issues relating to the results of the survey. The aim of focus group discussions is to provide qualitative data to aid in interpretation of the survey results, clarify any ambiguities, and point out any related issues.

Mentor: Individuals with advanced experience and knowledge who are committed to providing upward support and mobility to their protégés' careers (Hunt & Michael, 1983)

Structured Interview: An interview in which the interviewer uses a fixed set of questions and asks them in the same order of all respondents.

Survey Feedback Intervention: An organizational change strategy in which employees provide information about current workplace conditions via survey. Specific plans for organizational change are driven by the strengths and opportunities for improvement identified in the survey.

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Teaching Gender Inclusive Computer Ethics

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INTRODUCTION

Computer ethics as a subject area is finally being debated in wider computer science and information technology academic circles. In most computer science departments the syllabus is based on publications often written specifically to deliver courses. These texts select and prioritize those computer ethics topics seen by the professional bodies as the most important for a computer professional. Much rarer are courses which analyse questions of access and social exclusion, disability, global and green issues.

What has not yet been included in any systematic or conscientious way in the computer ethics syllabi are the questions of gender and associated ethical issues. Most students and staff are still not aware that all computing and ICT related areas are innately gendered and that a cohesive body of research material is available in the form of feminist or gender research in conference papers, proceedings and book publications.

This article analyses the progress of inclusion of gender in computer ethics and argues that the inclusion of gender issues in computer science curriculum must be accommodated. The article outlines how gender issues can be applied to individual computing disciplines in appropriate forms relevant across the spectrum of students.

BACKGROUND

Computer Ethics

Computer ethics is a field that is now widely recognized as a field of philosophical, political, and social enquiry in the use and construction of computing technology. There are now conferences devoted entirely to this field (e.g., ETHICOMP, CEPE) and in Britain there is The Centre for Computing and Social Responsibility at DeMontford University. The first PhD students graduated in this discipline in 1998.

The computing professional organizations embraced computer ethics quite early in the computer's history. In particular, the Association of Computing Machinery (ACM) and Institute of Electrical and Electronics Engineers (IEEE) began debating ethical issues concerning mainly computer hardware and its construction in the 1960s. In 1993 a task force combining members of the ACM and IEEE created a new computing curriculum, which embraced the social, ethical, professional, and legal issues of computing. The perception of ethical issues in this curriculum was rather simple and issues of gender and equality did not appear; yet it was a very advanced beginning (History of the Joint IEEE Computer Society and ACM Steering Committee for the Establishment of Software Engineering as a Profession, 1999).

The British Computer Society (BCS) published both the *Code of Conduct* and the *Code of Good Practice*. In terms of ethical professional behaviour, both publications now prioritise the user and the public as sites of good practice. The BCS course accreditation criteria concerned with ethical issues have also developed from initially only acknowledging the inclusion of the relevant legislation and the Codes itself in the curriculum, to containing a full appendix called "Legal, Social, Ethical and Professional Issues." While not mentioning equal opportunities explicitly, these make references to the Learning and Teaching Support Network (LTSN) computer ethics resource site where some equal opportunities material appears.

The ACM and the National Science Foundation (NSF) sponsored the first course on how to teach computer ethics to computing students in 1998. This course was aimed at U.S. academics, mainly computer scientists and concentrated mainly on issues of professionalism, codes of conduct, hacking, privacy, legislation and the environment. The course did not deal with equality, gender, race, or disability. Since

1998, there have been two other such courses, results of which were communicated to the NSF and the ACM/IEEE in a form of recommendations. The third course in 2001 accepted a gender scenario and gave space to a debate on gender and computing. The meeting of experts at this get-together contributed to a Special Issue of ACM SIGCSE Bulleting Inroads on Women and Computing (2002).

The British Computer Society, sponsored by the LTSN, have called to date three one-day conferences on delivering computer ethics to computing students. These conferences brought together computing academics, who were already interested in this field and who wanted to exchange their experiences and discuss how best to bring the subject to our students. The first conference (in 2000) resulted in the online LTSN resource.

Computer Ethics and Gender

James More (2001) described the development of computing as having three stages: the introduction stage, the permeation stage and the current power stage, which presents the most serious legal, ethical, and social questions. He describes a "policy vacuum," which is currently present and has resulted in the ever-increasing use of information and communication technology in its many forms and disguises. He urges that our "conceptual muddles" are cleared first, before any policy can be formulated. While More's thoughts were on issues such as data protection, the same applies to gender power relations in computing.

To investigate these conceptual muddles in relation to gender in computer ethics a clarification of feminist ethics is necessary. Feminist ethics accepts the experiences of women of any origin, status, sexual orientation, education etc as valid within the context of their social experiences (Porter, 1999). It includes and interrogates the meaning of traditional ethics in relation to these experiences and proposes alternatives to existing perceptions and social behaviours. Feminist ethics criticize the gender-blindness in traditional ethics and gender bias in all walks of life. In computer ethics specifically it examines all three broad areas of computing: the area of design and creation of computing technology, the area of personal and business uses of it and the area of computing education.

As a theory of moral behaviour, ethics draws on the traditional masculine perceptions and experiences, which inform the social systems creating acceptable standards of behaviour, legislation, and perceptions of equality. Feminism investigates the power relations between men and women and exposes their political nature. Feminist ethics attempts to develop social morality, which puts women's equality and emancipation in the centre of moral prescription (Adam, 2005). This of course calls also for men's recognition of the issues and ultimately for changes in men's attitudes. The complex issues of equality and in particular equality in the working environment (Bednar & Bissett, 2001) should be included in the teaching of computer ethics.

The major ethical issue is the under-representation of women in the computing industry and education. Many have documented the decreasing numbers of women in the last 20 years (Camp, 2002; Martin, Liff, Dutton, & Light, 2004; Mortleman, 2004; Turner, 2001) and argued that the lack of women's participation in the creation of technology is excluding a substantial body of human experience from being used in the process (Crutzen 2005; Schiebinger, 1999; Suchman, 1994). The questions of working conditions (e.g., Adam et al., 2005; Richardson & Richardson, 2001) and the expectations the computer industry has of their employees are almost Victorian. Unionization is non-existent and the workers are often expected to be on call 7 days/week. The lack of opportunities for women to return after career break and gender and race discrimination at the point of entry into the profession (e.g., Camp, 2002; Turner, 2001) have often been blamed for women not choosing to work in the industry.

Women are not equally paid for equal work in many industries and the computing industry is not an exception (Martin et al., 2004). The glass ceiling phenomena in the computing is probably worse than in many other industries. While the number of women managers is increasing in the Western countries, the computer industry's own statistics still indicate that only 8% of top management positions are occupied by women (Ezine, 2004).

It is necessary to remember, that while the numbers of women in computing education are extremely low, according to Martin et al. (2004) there are some "50,000 women with science, engineering and technology degrees (including computing)" in the UK alone, who are not using their qualifications. Arguably bringing more women into education is, in itself, not likely to remedy the situation in the industry.

Equal opportunities as an ethical issue guarantee not only equal rights of access but also rights to equal treatment. The low numbers demonstrate that for a variety of reasons women do not have equal access into the profession. The technology created in their name is thus created without their input. Technology is only useful if it helps to improve the position of those who use it and thus feel an ownership of it. It should exist to empower those whose power is socially suppressed (Everts, 1998; Rathgeber & Adera, 2000; Taylor, 2002). Questions of access to computer technology for women all over the world whether for education, business, information, or leisure are an issue of equal opportunities, power, and democracy for women. We talk of virtual democracy, global village, information age, globalisation, global communication, etc, all concepts loaded with socially based meanings in which women have "globally" little representation precisely because of their exclusion from access to creation and uses of ICT.

There is evidence of segregation of men and women and strong gendering of those working in the computing industry. This is an active product of the development of the industry and its power relations (for literature see IFIP WG 9.1, WiC, and ETHICOMP conferences). Women's achievements are not recognized and the power structures within the occupation keep them alienated (Turner, 2001). Studies have shown that in all we do we are influenced by our own experiences and thus if a gender split exists in the workforce, then the end product cannot reflect the needs of those for whom the technology is being constructed. These are questions of justice and fairness as well as issues of quality (e.g., Greysen, 2005; Thimbleby & Duquenoy, 2001; Turner & Stepulevage, 2000).

FUTURE TRENDS

Computer Ethics in Education

There are a number of papers on teaching computer ethics to computing and IT students. The ETHICOMP (see proceedings 1998, 1998, 2001, 2002, 2004) conferences are one of the main forums for those who teach computer ethics to meet and exchange experiences. There is as yet a debate to be had, where and when and how to include gender in these curricula.

Some ethical content is now delivered in many relevant degree programmes in Europe and the U.S. The perceptions of what are the most important issues in this area are often informed by the need to satisfy the accreditation criteria of professional bodies.

In 2001, no computer ethics courses "included the ethical issues of gender and race (except in questions of pornography and freedom of expression" (Turner & Roberts, 2001, p. 224). Pornography on the Internet is often debated as an issue of freedom of expression and freedom of an individual but without any gender analysis. In 2005, (Turner, unpublished) an Internet pole of 110 mainly UK academics and a short study of UK universities computing curricula posted on the web found that in 20 British universities only two undergraduate and two masters modules included a lecture on gender delivered by individual lecturers interested in the issues. Only a few universities in Europe, USA, Australia, and elsewhere include gender in their computing curricula, these being delivered by lecturers personally interested in the issue. This is a sad indication of how little understanding of gender issues the large numbers future computer professionals take with them into their working lives.

The Gender Inclusive Computer Ethics Curriculum

The computer science and ICT curriculum needs to be re-shaped and re-thought to include gender issues in such a format, that the students will understand it, accept it and take it into their working lives. Perceiving them as an integral part of ethical and social debates around technology needs to become the norm, not the exception. Gender inclusive computer ethics therefore needs to permeate the curriculum throughout the students' study.

The gender issues need to be owned by the school/department and made a priority when the current curriculum is re-structured. They should be discussed at "teaching and learning" meetings so that staff can learn from each other. Gender issues can be documented and related to students on case studies and real life examples and resourced by the literature now available. These additions do not have to reduce the amount of the technical material delivered.

Teaching strategies should be adopted for each curricular subject area. Programming, hardware/computer architecture, systems analysis/database theory/ software engineering, internet and networks are areas which re-occur in a variety of forms throughout the degree programmes. In each, the lecturers should present debates related to gender whether on products and their use, the nature of gathering data and information or creation of gendered web content. The class should discuss the professional's social responsibility related to gender, women's working conditions in developed and developing worlds, interface design, computer game production and gender power relations, not least in students' group assignments. Staff and students should note how they interact in computer labs, what verbal communication takes place and which student gets the most help, when and how.

Only then can a computer ethics module be delivered at a higher level. If the above suggestions are followed, then by this level the students will have a considerable awareness of issues related to gender. They will have been given case studies to work through and had discussions based of real experiences. This module can thus give all that learning experience some formal theoretical and analytical framework. The students can be introduced to ethical and feminist theories, which can be used to analyse a wide variety of ethical, professional, and cultural issues of computing. Most of these issues have a gender element which students should be encouraged to include in their discussions.

An important contribution to a critical debate on gender politics is the Shadow Report on Equal Opportunities (Pavlik, 2004), which is a unique and welcome publication. In most cases computer dissertations students are neither required to include ethical issues in nor to provide any gender analysis of the topic concerned. Only too often an extended computer program is sufficient for a dissertation, with no theoretical section on social and ethical analysis of the environment for which it is being written. It should be imperative on all dissertations to include such a theoretical section, which would require students to investigate gender issues relevant to the theme of their project.

CONCLUSION

In the year 2000 there were a few computer science departments delivering computer ethics courses to their students. The call among academic staff particularly interested in this area of computer science was for the academic management to consider a module in computer ethics a priority (Turner, 2000).

Five years down the road most computer science departments have introduced some form of professional and ethical issues into their teaching, but only very few have included gender as an important topic in their "professional" delivery.

While the experts debate the future direction of computer ethics, they mostly do not include gender in their discussion (e.g., contrast Weckert, 2001; Tavani, 2002, with Adam, 2004). Where they talk about women, they mention them as victims. However there are now more academic researchers and women practitioners world wide, interested in and talking about gender issues in computing. It is important that we promote an atmosphere of acceptance so that the analysis and the delivery of this material becomes an integral part of our teaching. The responsibility for departmental ownership of the issues and their delivery lies still with the deans, heads of schools and university policy makers as well as the professional organisations themselves.

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KEY TERMS

Association of Computing Machinery (ACM) and Institute of Electrical and Electronics Engineers (IEEE): U.S. professional associations for IT and computing professionals. (http://www.acm.org and http://www.ieee.org/)

British Computer Society (BCS): The British Computer Society (BCS) is the industry body for IT professionals, and a chartered engineering institution for information technology (IT). (http://www.bcs.org/)

Computer Ethics: Computer ethics is a branch of practical philosophy which deals with how computing professionals should make decisions regarding professional and social conduct. (en.wikipedia.org/wiki/Computer_ethics)

Learning and Teaching Support Network (LTSN): A British independent organisation working with academic institutions on teaching and learning initiatives, it is now called The Higher Education Academy. (http://www.heacademy.ac.uk/)

National Science Foundation (NSF): U.S. government organisation which supports science and engineering research and education. (http://www.nsf.gov/)

A Techno-Feminist View on the Open Source Software Development

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INTRODUCTION

Current debate on women in free/libre open source software (FLOSS) tends to fall into the gender stereotype of men and women when coming across to the gender issue. This article stays away from a reductionism that simplifies the gender issue in the FLOSS community to the level of a fight between men and women. Instead of splitting women from men in the FLOSS development, this analysis helps motivate both men and women to work together, reduce the gender gap and improve the disadvantaged statuses of women and a wider users' community in the FLOSS development. More importantly, it addresses not only the inequality that women face in computing, but also other inequalities that other users face, mainly emerging from the power relationships between expert and lay person (namely, developer and user) in software design. In so doing, the issue at stake is not only to create a welcome environment for women to join the FLOSS development, but also to come up with a better way of encouraging both sexes to collaborate with each other.

This article starts from how FLOSS can make a difference for today's information society, and present some successful stories of implementing FLOSS in developing countries and rural areas to empower women and the minority. Consequently, it discusses the problem of including more women and the minority in the FLOSS development through deconstructing the myth of the programming skill.

BACKGROUND

The essential element of FLOSS is "freedom" that allows users to run, copy, redistribute, study, change and improve the software. By having source code made available to the public, interested users or developers can study and understand how the software is written and, if competent, they can change and improve it, as well. In other words, apart from serving as an alternative choice for consumers, FLOSS helps open up the black box of software technologies, facilitate the practice of participatory design and provide an opportunity of breaking down the hierarchy of professional knowledge. And this could lead to improved security and usability, because users can configure software to fulfill their local requirements and secure against vandalism, user errors and virus attacks.

Given these opportunities, FLOSS has been adopted and implemented in several developing countries and rural areas. For instance, believing that FLOSS serves as a better technological tool to bridge the digital divide, Brazil, for example, has also required any company or research institute that receives government financing to develop software to license their work under FLOSS licenses, meaning the underlying software code must be free to all (Benson, 2005). In the wave of localization and customization, a group of volunteers in India has started the IndLinux[1] project to create a Linux distribution that supports Indian Languages at all levels. These examples are just two of the many ongoing projects around the world. These continuously emerging cases demonstrate that FLOSS provides a better basis for more widespread access to information and communication technologies (ICT), more effective uses and a much stronger platform for long-term growth and development compared with scaled-down versions of proprietary software.

However, such FLOSS-based technologies meant to be used widely and to empower users have not yet engaged with a diverse range of people in development and implementation. So far, the freedom of FLOSS seems to be enjoyed only by those who are capable of manipulating the technologies. We see imbalanced population distributions in the FLOSS-based knowledge demography, and the unbalanced gender distribution is among those top ones. We see a strong programming culture in the FLOSS development and implementation nowadays—if one does not program, he or she seems to be left out of the FLOSS movement. In other words, instead of breaking down the hierarchy of professional knowledge, a new boundary and barrier of accessing ICT knowledge seems to be established. Abbreviations such as "RTFSC" (Read The F***ing[2] Source Code) or "RTFM" (Read The F***ing Manual) shows how strong this hegemony of software knowledge is. This article aims to challenge the workship on programming knowledge, which is one of the many reasons that causes gender inequality in FLOSS (see Henson, 2002; Lin, 2006).

I would like to stress that to be involved in the FLOSS development, one needs not be a programmer (see Rye, 2004); one could write documentation, report or triage bugs, improve graphic or text content, translate/localize, submit feature-requests or teach how to use FLOSS. These activities are equally important to programming in the software innovation process, because software is not ready to use just as it is written. It needs many efforts to make it user friendly, implement it in different contexts and maintain it over time (Levesque, 2004). To make FLOSS successful, we need not only Richard Stallman or Linus Torvalds, but also a great amount of volunteers reporting and fixing bugs, writing documentation and, more importantly, teaching users how to use OpenOffice.org and Mozilla Firefox browser. When thinking of an approach of including more women and improving the representation of women in FLOSS, these activities can be considered as essential.

Saying that we should start encouraging women to participate in these activities does not imply that women are not good at programming. Not at all! While it is generally recognized that there is no genuine biological difference between men and women in science (American Sociological Association, 2005), the history and cultural and educational backgrounds in turn lead to the circumstance in which many women nowadays do not have as strong programming experience as men do. Given this, we may need an alternative way of including women in FLOSS. But more importantly, it is because neither of these activities (e.g., documentation and localization) are subordinate to programming, nor are they peripheral in any case, and we need to encourage women and other minority user groups to participate in these activities in the FLOSS development.

These efforts on documentation and localization (including translation) are so important that they are the keys to opening the black box of the software technologies and allowing more people (regardless of gender, class, race and disability) to participate in the FLOSS development. While some people try to degrade the skill of writing documentation or translation, an experienced female FLOSS user, Patricia Jung, emphasized the importance and challenge of writing documentation on the Debian-women mailing list:

Documentation can be a means of quality insurance, and this power is far too seldom used, not only in Open Source development. The people who write the best code I know write documentation alongside or even before coding: The code has to follow documentation, otherwise it's a bug :), at least documentation and code are never allowed to get out of sync. Which means documentation _is_ development, not just something subordinate.

In a scenario like this, documentation and usability are not just nice to have but an inherent part of development and equally important as writing code, and it finally leads you to better software, to software that is aware of its users and tasks and not just aware of how things are easiest, smartest to implement. But it requires a paradigm shift: Coders are no longer allowed to see documentation as a nasty add-on, as something subordinate, and documentation people don't simply have to follow the software they get but allowed and required to intervene. Software isn't released as long as the doc people don't give their go: Right now code matches documentation, it does what it is supposed to do, now we can release. (Debian-Women, 2005)

Jung's message demonstrates that coding is neither the only nor the foremost activity in the FLOSS innovation process. Programmers do not play a more important role than other contributors in the FLOSS development. The FLOSS community is comprised of diverse people from different social worlds, and each member should gain equal respect from what they do. FLOSS cannot get widespread without people writing documentation, reporting bugs and mentoring. The value of the FLOSS development is embedded and embodied not only in coding and the resulting code, but also in the process of collaboration, networking with others, sharing knowledge and experiences, learning and helping reciprocally. FLOSS gives us a chance to see the co-construction of social and technical activities in a socio-technical innovation process. With a techno-feminist perspective (Wajcman, 2004; Faulkner, 2000, 2001) on the FLOSS development, the socio-technical complexity in the FLOSS community can be observed more deliberately on their power relationships: the haves and have-nots in programming. Strengthening this gap would bring the problem to all members involved (regardless of gender, race, class and disability) in the FLOSS development, rather than just men and women. And this would also clarify the misunderstanding on feminism: Feminism cares not only about the inequality between men, women and other genders, but all inequalities in the society. In other words, involving more women in the documentation or localization (and internationalization) of FLOSS should not turn these fields into a female domain that it might ironically end up somehow cheapening the work suggested by some old thoughts about certain things being women's work; instead, such a conflicting situation raises the question on non-programming work in software design that is continuously undermined and devalued. To mitigate this unbalance, we need to take a feminist perspective, treating the whole mechanism of software design as a "socio-technical system" (Hughes, 1979, 1987; Latour, 1983, 1999; Pinch & Bijker, 1987), "recognizing the various forms of visible and invisible work that make up the production/use of technical systems, locating ourselves within that extended web of connections, and taking responsibility for our participation" (Suchman, 1999, p. 263). The biased power relationships between men and women, developers and users, experts and lay person inscribed in the strong technological determinism in the FLOSS development can be overcome through valuing heterogeneity and situated knowledge in the FLOSS community (Haraway, 1991; Lin, 2004).

FUTURE TRENDS

As argued, FLOSS has a potential of being a platform providing both men and women, expert and lay person with equal opportunities to develop and implement software together. But realizing this potential still requires more deliberate efforts. Many women-led FLOSS groups have been tackling the knowledge gap between expert and lay person (not only men and women) and challenging the "masculine" culture in the FLOSS community. Three examples below show how women are encouraged to become mobile grass-roots information technology (IT) workers supporting organizations and individuals with advice on technology with non-technical language, rather than just coding.

LinuxChix

LinuxChix[3] is a community for women Linux enthusiasts and for supporting women in computing. The membership ranges from novices to experienced users, and includes professional and amateur programmers, system administrators and technical writers. It aims at creating a more hospitable community in which people can discuss Linux, a community that encourages participation, that does not allow the quieter members to be drowned out by the vocal minority. LinuxChix was aimed at women, and it remains primarily a group for supporting women in computing. LinuxChix now has several branches around the world, including LinuxChix Brazil[4] and LinuxChix Africa[5].

Debian-Women

The Debian-Women[6] project, founded in May 2004, seeks to balance and diversify the Debian[7] Project by actively engaging with interested women and encouraging them to become more involved with Debian. Debian-women promotes women's involvement in Debian by increasing the visibility of active women, providing mentoring and role models, and creating opportunities for collaboration with new and current members of the Debian Project. All people (both men or women) who are interested in increasing the participation of women in Debian are welcome. Now Debian-Women has a mailing list running for discussion of related issues, and an Internet relay chat (IRC) channel for discussion of related issues, technical questions and to allow women who are interested in contributing to Debian to meet each other and some of Debian's current contributors. The members also eagerly give talks at conferences, and organize "birds of a feather" (BOF) discussions at Linux conferences to promote discussion of issues concerning women and their involvement in Debian and Linux. These activities have effectively encouraged and educated the Debian community to increase understanding of these specific issues concerning women who wish to contribute more to Debian.

Women's Information Technology Transfer (WITT)

WITT[8] is a portal site to link women's organizations and feminist advocates for the Internet in Eastern and Central Europe. It aims at providing strategic ICT information to all, and supporting, in a collective way, Central and Eastern European women in developing the Web as an instrument in their social activism. WITT is committed to bringing women's actions, activities and struggles into the spotlight, promoting the use of FLOSS as a way to highlight women's voices. The WITT Web site has been developed for women to share their experiences with ICT, to learn about training events provided by WITT and to develop expertise in advocacy on gender and ICT issues. Women can publish on the Web site in their own language (eight languages are available to be used as the site develops).

CONCLUSION

The features of FLOSS have been said to open a range of opportunities to change the power relationships in society: experts and lay people, developers and users, developed and developing countries, rich and poor and so forth. The feature of low development cost, modularized features and transparent information are particularly celebrated in a knowledge-based society. Whereas FLOSS is represented as a weapon to fight against proprietary software companies, such as Microsoft, neither have we seen an equal status for all members involved in the FLOSS development, nor have we seen an accessible channel for all interested people to enter this world. Drawing on new perspectives in feminist theory and science and technology studies, I challenge the power emerging from the skills of programming and designing technologies that overlooks the requirements of having user-friendly technologies. And it is exactly because of this misconception on the coding skill that makes the composition and structure in the FLOSS social world imbalanced. This misconception fosters a false impression that FLOSS is too technical and difficult to use. This kind of misunderstanding discourages many people, including women, to participate in the FLOSS development, and subsequently results in an imbalance in gender, race and class. Today, when we criticize women's status in the FLOSS social world, we must not forget that a feminist critique not only applies to gender issues, but it aims to challenge all kinds of power inequalities in the world. I have proposed to take a critical view on the attitude in favor of (if not worshiping) people who own programming skills when examining the reason why there are so few women in FLOSS. Instead of narrowing the gender argument to a fight between men and women, I argue that this is not only about men and women, but about all majority and minority, the powerful and the powerless class. In viewing the problem from a techno-feminist angle, we can overcome many dilemmas, such as whether designing software for women is needed. After all, it is not whether software should be designed for men or for women; it is whether the software is designed for users without taking too much pride of the developers. Three women-led FLOSS groups working persistently in this direction were introduced: LinuxChix, Debian-women and WITT. These groups facilitate networking and provide mutual help among women participants in the FLOSS development and computing. They help maintain a pool of women who will not only promote ICT use but also promote a feminist approach of design and usage of ICT. Although this article has focused on the gender-related issues specifically in the FLOSS development, the analytic concepts introduced here can and should be widely applied to software design and other technological designs to explore the ways in which technologies are gendered in their design and use.

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Wajcman, J. (2004). *Techno feminism*. Cambridge, UK: Polity Press.

KEY TERMS

Coding or Programming: The craft of implementing one or more interrelated abstract algorithms using a particular programming language to produce a concrete computer program.

Debian GNU/Linux: Debian, organized by the Debian Project, is a widely used distribution of free software developed through the collaboration of volunteers from around the world. Since its inception, the released system, Debian GNU/Linux, has been based on the Linux kernel, with many basic tools of the operating system from the GNU project. The project Web site is accessible at http://www.debian.org/.

GNU/Linux or Linux: A computer operating system that is one of the most famous examples of free/libre open source software (FLOSS) development. Unlike other major operating systems (such as Windows or Mac OS), all of its underlying source code is available to the public and anyone can freely use, modify and redistribute it.

LinuxChix: A community for women Linux enthusiasts, and for supporting women in computing. It aims at promoting interest in and learning about Linux among women around the world.

Mozilla: The Mozilla Organization was founded in 1998 to create the new suite. On July 15, 2003, the organization was formally registered as a not-for-profit organization, and became Mozilla Foundation. The foundation now creates and maintains the Mozilla Firefox® browser and Mozilla Thunderbird e-mail application, among other products. The project Web site can be accessed at http://www.mozilla.com/.

OpenOffice.org: OpenOffice.org is a free/libre and open source office suite, including a word processor, spreadsheet, presentation, vector drawing, and database components. It is available for many different platforms, including Microsoft Windows, Unix®-like systems with the X Window System including GNU/Linux, BSD, Solaris, and Mac OS X. It is intended to be compatible and complete with Microsoft Office; it supports the OpenDocument standard for data interchange; and it can be used at no cost. The project Web site can be accessed at http://openoffice.org/.

Science and Technology Studies (STS): A field in academic research devoted to studying how scientific knowledge is produced, maintained and used. Studies done in this field usually are interdisciplinary and multidisciplinary, involving mainly anthropology, history, philosophy and sociology.

Socio-Technical Systems: An analytical concept describing how technology is created, maintained and used. Staying away from technological determinism, the term stresses the reciprocal interrelationship between humans and technologies.

Techno-Feminism (or Feminist Technology Studies): Both a branch of feminism and that of science and technology studies. This dualist theory studies the co-construction of gender and technologies, how such mutual-shaping influences both how technologies are designed and used, and how gender identities of users and designers are perceived and articulated.

Women's Information Technology Transfer (WITT): A portal Web site to link women's organizations and feminist advocates for the Internet in Eastern and Central Europe. It aims at providing strategic ICT information to all and supporting, in a collective way, Central and Eastern European women in developing the Web as an instrument in their social activism.

ENDNOTES

1. http://www.indlinux.org
2. To show politeness, the word "f***ing" now usually is replaced with the word "fine" or hidden in the abbreviations. But the meaning and the way it is used does not change.
3. http://www.linuxchix.org
4. http://www.linuxchix.org.br/
5. http://www.africalinuxchix.org/
6. http://www.debianwomen.org
7. http://www.debian.org
8. http://www.witt-project.net/

Theorizing Gender and Information Technology Research

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INTRODUCTION

A fundamental consideration when attempting to understand the complex factors leading to the underrepresentation of women in IT is the choice and use of theory. Theories about women and their relationships to information technology and the IT profession guide the conceptualization of the research problem, the methods of data collection, the basis for analysis, and the conclusions that are drawn. However, a criticism of gender and IT research is that the topic of gender and IT is currently undertheorized (Adam, Howcroft, & Richardson, 2001, 2004).

This undertheorization takes on several different forms. First, there are cases in which there is no theory in evidence to guide the conceptualization of the research project or to inform the data collection and analysis. Rather, the focus is typically on compiling and representing statistical data regarding the differences between men and women with respect to technology adoption, use or involvement in the IT profession. This form of undertheorization can be labeled *pre-theoretical research*. Second, other research, while not explicitly articulating a particular theory, nevertheless, is guided by a theory-in-use. For example, quite often a theory of inherent differences between males' and females' relationships to IT is used implicitly to guide data collection and analysis. This form of undertheorization can be labeled *implicit-theoretical research*. This approach is considered to be a type of undertheorization in that the lack of explicit discussion of a theory makes it difficult for others to discuss, challenge or extend the research. Finally, the body of research that reflects explicit theory-in-use has been shown to have gaps in the theoretical landscape (Trauth, 2002). That is, an argument has been made that current theories about gender and IT do not fully account for the variation in men's and women's relationships to information technology and the IT field. This form of undertheorization can be labeled *insufficient-theoretical research*. It is this third condition that is addressed in this article: the need for new theoretical insights to guide our effort to understand the underrepresentation of women in the IT profession.

BACKGROUND

Two dominant theoretical viewpoints are currently reflected in the majority of literature about gender and IT: essentialism and social construction (Trauth, 2002). Essentialism is the assertion of fixed, unified and opposed female and male natures (Wajcman, 1991, p. 9). The existence of biological difference between the sexes has led to a tendency to assume that other observed differences between men and women are due to biological determinates as well (Marini, 1990). When applied to the topic of gender and IT, the essentialist theory presumes the existence of relevant *inherent differences* between women and men with respect to information technology. It uses the observed differences in the participation of women and men in the IT field as evidence of this view. Thus, the causes of gender underrepresentation in IT are attributed to biology. It turns to observed differences in men's and women's behavior for explanations of what are believed to be inherent, fixed, group-level differences that are based upon bio-psychological characteristics.

Essentialism underlies research on gender and IT that views gender as a fixed variable that is manipulated within a positivist epistemology (e.g., Dennis, Kiney, & Hung, 1999; Gefen & Straub, 1997; Venkatesh & Morris, 2000). Adam et al.'s (2001) analysis of this perspective points out that focusing on a background literature of psychology, alone, places too much emphasis on individual gender characteristics where a form of essentialism may creep in. Looking only to psychological explanations of observations without giving attention to the influence of context[1] results in a determinist stance with respect to gender.

One inference that could be drawn from an essentialist approach to gender and IT research is that women and men should be treated differently. For example, Venkatesh and Morris (2000) recommend that trainers adopt different approaches toward men and women and that marketers design different marketing campaigns for men and women. Trauth's critique of essentialist approaches to gender and IT research suggested that one logical extrapolation from this line of thinking to IT workforce considerations would be the creation of two different workforces: a "women in IT" workforce and a "men in IT" workforce. Thus, policies for addressing the gender imbalance would focus on differences between women and men and the equality issue would focus on "separate but equal," something that was rejected in the arena of racial equality decades ago (Trauth, 2002; Trauth & Quesenberry, 2005; Trauth, Quesenberry, & Morgan, 2004).

The other dominant theoretical perspective focuses on the *social construction* of IT as a male domain. According to this theory, there is a fundamental incompatibility between the social construction of female identity and the social construction of information technology and IT work as a male domain. This explanation for women's relationship to information technology looks to societal rather than biological forces. Thus, the causes of gender underrepresentation can be found in both the IT sector and in the wider society.

The literatures of gender and technology in general (e.g., Cockburn, 1983, 1988; Cockburn & Ormrod, 1993; Wajcman, 1991) and that of gender and information technology, in particular (e.g., Adam et al., 1994; Balka & Smith, 2000; Eriksson, Kitchenham, & Tijdens, 1991; Lovegrove & Segal, 1991; Slyke, Comunale, & Belanger, 2002; Spender, 1995; Star, 1995; Webster, 1996) look to social construction theory (Berger & Luckmann, 1966) rather than biological and psychological theories. According to this view, the social shaping of information technology as "men's work" places IT careers outside the domain of women.

Recommendations for addressing this situation vary. One school of thought based on a multi-year investigation of female underrepresentation in both academe and the workplace in Australia explores the development of strategies to help women fit in to this male domain (e.g., Nielsen, von Hellens, Greenhill, & Pringle, 1998; Nielsen, von Hellens, Pringle, & Greenhill, 1999; Nielsen, von Hellens & Wong, 2000; Pringle, Nielsen, von Hellens, Greenhill, & Parfitt, 2000; von Hellens, von Hellens, Nielsen, & Trauth, 2001; Pringle, Nielsen, & Greenhill, 2000). Another school of thought focuses on the need to reconstruct the world of computing to become more of a "female domain." For example, Webster (1996) focuses on the social shaping of female gender identity and the implication for women's relationship to workplace technologies. Based on analysis of women as a social group in cyberspace, Spender (1995) predicted an influx of "female values" into the virtual world that would accompany increased female presence.

Wajcman's (1991) analysis of the social constructivist perspective on gender and technology reveals several issues. For example, there is no universal definition of masculine or feminine behavior; what is considered masculine in one society is considered feminine or gender-neutral in another. Further, while gender differences exist they are manifested differently in different societies. Hence, addressing the gender gap in IT employment based upon an assumed "woman's perspective" is problematic. This analysis suggests a gap in current theory and motivates the articulation of new theory to help us better understand the underrepresentation of women in the IT field.

MAIN THRUST OF THE ARTICLE

The need for an alternative theory to account for the underrepresentation of women in the IT workforce emerges from consideration of the assumptions underlying the two prevailing theories discussed in the previous section. The initial work on the Individual Differences Theory of Gender and IT resulted from an analysis of this theoretical gap and used empirical data from a study of gender and IT in Australia and New Zealand (Trauth, 2002; Trauth, Nielsen, & von Hellens, 2003) to make the case for an alternative theory to occupy the space between essentialist theory and social constructionist theory. Subsequent work has focused on greater articulation of this theory (Trauth & Quesenberry, 2005, 2006; Trauth et al., 2004, 2006) and empirical testing of it (Morgan, Quesenberry, & Trauth, 2004; Quesenberry & Trauth, 2005; Quesenberry, Trauth, & Morgan, 2006; Trauth, Quesenberry & Yeo, 2005).

The Individual Differences Theory of Gender and IT addresses the undertheorization of gender and IT by offering an alternative theory that focuses on *individual differences* among women as they relate to the characteristics of IT work and the IT workplace. This view finds the causes of gender underrepresentation in the varied individual responses to generalized societal influences. Thus, it represents the middle ground between the essentialist and social constructionist theories. In doing so, it investigates the individual variations across genders as a result of the combination of personal characteristics and environmental influences in order to understand the participation of women in the IT workforce. Hence, the focus is on differences *within* rather than *between* genders. The theory also views women and men as individuals who possess different technical talents and inclinations and respond to the social shaping of gender in unique and particular ways that vary across cultures. This individual differences theory takes into account the uniformity of social shaping messages conveyed in a culture. However, it also takes into account the varied influence of individual background and critical life events that result in a range of responses to those messages.

The individual differences theory is comprised of three general constructs that, together, explain women's decisions to enter and remain in the IT field. The individual identity construct includes both personal demographic items (such as age, race, ethnicity, nationality, socio-economic class, and parenting status) and professional items (e.g., industry, type of IT work, etc.). The individual influence construct includes personal characteristics (e.g., educational background, personality traits, and abilities) and personal influences (e.g., mentors, role models, experiences with computing, and other significant life experiences). The environmental influence construct includes cultural attitudes and values (e.g., attitudes about IT, about women in IT), geographic data (e.g., about the geographical location of one's work) and economic and policy data (e.g., about the region/country in which one works). The Individual Differences Theory of Gender and IT posits that, collectively, these constructs account for the differences among men and women in the ways they experience and respond to characteristics of IT work, the IT workplace and societal messages about women and men and IT.

CONCLUSION

It is ironic that coincident with a documented need for a deeper understanding of the gender imbalance in the IT field, there is insufficient attention being paid to theorizing gender and IT. Given this need, greater theorization in gender and IT research can contribute in several ways to a better understanding of women's relationship to information technology. First, it can lead to more theoretically-informed treatments of gender in IT research. Wajcman (2000) has observed that gender is seldom considered a relevant factor in socio-technical studies of IT in context. Second, much of the published work that does focus on gender places emphasis on data analysis rather than theoretical implications and linking these results to the existing body of gender, and gender and IT literature (Adam et al., 2001). Hence, greater explicit use of theory can strengthen the existing body of gender and IT research. Finally, insufficient attention has been paid to the differences *among women* rather than *between women and men* with respect to information technology adoption, use and work. The development of the Individual Differences Theory of Gender and IT is intended to address this need by providing additional theoretical insights to help us to better understand the individual and environmental forces that account for the underrepresentation of women in IT. It accomplishes this by focusing on women as individuals, having distinct personalities, experiencing a range of socio-cultural influences, and thus exhibiting a range of responses to the social construction of IT. This, in turn, can facilitate more nuanced studies of gender that explore the multiple identities of women—for example, race and gender, or sexual orientation and gender, or age and gender—and their relationships to information technology.

One stream of future work will explore the role of epistemology and methodology in conducting gender and IT research using the Individual Differences Theory of Gender and IT. Another stream of research will explore the contribution of organizational factors to the underrepresentation of women in IT by focusing on the articulation of workplace factors that enhance and inhibit women's participation in IT work and women's varying responses to them. A third stream of research will apply the individual differences theory of gender and IT to an examination of differences in Internet search behavior across a variety of uses.

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KEY TERMS

Essentialism: The assertion of fixed, unified and opposed female and male natures (Wajcman, 1991, p. 9). This theoretical perspective is used to explain the under representation of women in the information technology field by arguing the existence of "essential differences" between males and females with respect to engagement with information technology.

Individual Differences Theory of Gender and IT: A social theory developed by Trauth (Trauth, 2002; Trauth et al., 2004) that focuses on within-group rather than between-group differences to explain differences in male and female relationships with information technology and IT careers. This theory posits that the under representation of women in IT can best be explained by considering individual characteristics and individual influences that result in individual and varied responses to generalized environmental influences on women.

Social Construction: A theoretical perspective articulated by Peter Berger and Thomas Luckmann (1967) that focuses on social processes and interactions in the shaping of actors. This theoretical perspective is used to explain the under representation of women in the information technology field by arguing that technology—socially constructed as a masculine domain—is in conflict with socially constructed feminine identity.

ENDNOTE

[1] See Wilson and Howcroft (2000) for an example of how context enriches the analysis of observed differences in behavior toward IT based upon gender.

Theorizing Masculinity in Information Systems Research

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INTRODUCTION

I want to argue that understanding masculinity is an important part of understanding gender and sexuality as it relates to information and communications technologies (ICTs), specifically those under the lens of the information-systems community. In order to do this, the landscape of gender and sexuality research in general is referred to along with such research in the field of information systems (IS), with reference as necessary to masculinity studies. I will then suggest some possible areas where a more thoroughgoing theorization may prove useful. In sum, future research might focus on the relationship between marginalised masculinities and the construction and consumption of IS in work organisations and society.

BACKGROUND

For my purposes here, gender is seen as a system of social practices that creates and maintains gender distinctions, which are used to organise relations of inequality (Wharton, 2005). The field, which Beasley (2005) links with sexuality studies, can be broadly seen as comprising feminist studies, masculinity studies, and sexuality studies. Feminist studies refute the masculine bias of mainstream Western thinking and practices that render women marginal and distort understandings of men. These studies usually put women at centre stage. Masculinity-studies writers are largely social constructivist and profeminist in nature, and aim to critique and destabilise mainstream conceptualisations of masculinity. These studies usually put men at centre stage. Sexuality writers generally focus on lesbian, gay, and transsexual regimes with the similar aim of social destabilisation, usually from a postmodern perspective. Some feminist studies do consider sexuality, but in general, as with masculinity studies, the emphasis is on sexed regimes. Sexuality studies in turn generally pay less attention to gender. Within IS, gender-theory-informed work usually refers to feminist studies and the literatures on gender and technology (again, mostly feminist in nature). Masculinities and the gender link with sexualities are seldom theorized in any great depth. Here, the focus is mostly on masculinity, although I recognise the inextricable links between gender and sexual regimes.

GENDER, IS, AND THEORIZING MASCULINITY

Within IS, gender is a neglected area of investigation. As A. Adam (2002) points out, given gender is viewed as an important part of behaviour in the social sciences, and IS is often viewed as sociotechnical, with the social being as much a part of the genealogy of the area as the technical; it is then surprising that this aspect of the social is neglected. Certainly, gender relations are one of the few things in life that everyone has a stake in, yet this does not seem to enter the discussions about IS as being relevant. Instead, the focus is on relevance to the management of organisations in terms of such things as improving performance. Indeed, the landscape of gender and IS research is pretty limited. A. Adam, Howcroft, and Richardson's (2004) survey of the top mainstream IS journals unearthed only 19 papers published during the period of 1993 to 2002. They found, with a few exceptions, a lack of reference to the more general literature on gender and technology and a focus on using gender as a fixed variable. Moreover, those articles that theorized gender seemed to be free of a thoroughgoing theorization of masculinity. Looking toward the gender and technology literature, studies of masculinities and technologies are also sparse. Whilst Lohan and Faulkner's (2004) introduction to their special issue on masculinities and technologies states that feminist technology studies have much to learn from masculinities studies, and vice versa, they point out that the articles submitted came from the former, despite soliciting contributions widely. This dearth of research matters because whilst there may be some commonly recognised masculinity characteristics, it is necessary to understand the mutual shaping of these and technology. Indeed, those who study gender and technologies, specifically those in the area of feminist technology studies and gender and IS, subscribe to Wajcman's (1991) view of technology as a masculine culture. Moreover, IS is still recognised to be dominated by men as a field of academic study and in work organisations and society (Panteli, Stack, & Ramsay, 2001; Robertson, Newell, Swan, Mathiassen, & Bjerknes, 2001). So, gender is relevant to IS research, and I would suggest that developing a rigorous understanding of masculinities could contribute to the field.

A FOCUS ON MASCULINITIES STUDIES

It is necessary to distinguish between the men's movement that emerged in the 1970s and the academic study of masculinities. The men's movement tends to shore up stereotypical conceptualisations of Western masculinity and its dominant social status. Implicated in the movement are, for example, antifeminism and homophobia. Thus, the academic study of masculinities has an equivocal relationship with the mainstream politics of the men's movement. Masculinity-studies writers do not take up the cause of masculinity; they seek to understand and critique its role in gendered and sometimes sexual regimes. Additionally, in contrast to the men's movement, there is a more wide-ranging recognition of differences amongst masculinities. Masculinity is presented as involving the dominance of men over women and other men. From this there are two considerations.

First, who are these other men and masculinities? To answer this, it is necessary to direct attention to theorizations of masculinity that recognise multiple differences. In this respect, one of the most pervasive concepts in masculinity studies is that of hegemonic masculinity (Carrigan, Lee, & Connell, 1985; Connell, 1987). Hegemonic masculinity draws on Antonio Gramsci's concept of hegemonic domination. It is concerned with the idea that a particular definition of masculinity is culturally exalted and latently imposed upon those in society. This hegemonic masculinity is not seen as merely held by one person or group; it is institutionalised. In line with Wharton's (2005) more general theorization of gender, this locates the forces of oppression outside the individual and recognises its meshing with wider society. Thus, legal, welfare, and educational institutions and others like them become implicitly and explicitly imbued with the masculinity. This hegemonic masculinity subordinates competing masculinities and, of course, is used as a reference for subordinating femininities and constructing emphasized femininity (Connell, 1987). In terms of the domination of men by men, we can see competing, socially constructed categories of masculinities, such as race, age, ethnicity, sexuality, disability, and class, come into play—categories, of course, that are equally appropriate to women (Trauth, 2002). Indeed, as Lohan (2001) notes in relation to the domestic landline telephone, similarities and differences in the use of technologies and the construction of gender relations around these may vary in terms of age and sexuality. Moreover, she notes that such constructions might be further unpacked within any given group, as I shall illustrate later in relation to gay men.

The second point highlights contradictions in masculinity studies. Even though Connell (1987) states that masculinity is not inherently a man's characteristic, men are usually the foci of investigation. Thus, care has to be taken to avoid drifting into essentialist accounts of masculinity that determine it as the purview of one sex. Indeed, Halberstam (2002) argues that those who do not interpret masculinity as a synonym for men are rare. However, in Western society at least, that which is deemed masculine is constructed as held by men. For example, we could look at the film adaptation of the Marvel comic book *The X-Men* (2000). Ironically, in a fantasy world where anything is possible, the status quo prevails. The team is called the X-Men when there are several women members. We learn that two men built the supercomputer Cerebro and that it is too powerful for Dr. Jean Gray to use; she does not have the "control" Professor Charles Xavier has.

Although I have unpacked the idea of masculinity into masculinities, there are undoubtedly marginalised groups of men such as those who are black, gay, or disabled: They are still men. As such, it is important to recognise that in the main, these groups will still usually retain a relatively more privileged position in society as a whole. Their gender often compensates for the aspects of their identity that otherwise marginalise them. Certainly, it might be argued that masculinities research merely privileges the already privileged and steals the very limited space for discussing women. Moreover, assigning masculinity to women and marginalised groups of men implicates them in their own domination. This maybe goes some way to explaining why masculinity studies is filled with studies of white, middle-class, straight men, written mostly by white, middle-class, straight men; these men do not want to speak for other masculinities (Beasley, 2005). Yet, studying masculinities in a critical fashion, particularly with emphasis on marginalised masculinities, does have use. Of course, it is necessary to face the facts of gender power relations in relation to men, but it is also important to do this without simplifying the situation either. After all, if gender is relational, adequate theorizations of the concepts it comprises are required.

FUTURE TRENDS

So far, I have argued that masculinity would benefit from unpacking in gender and IS research, and have drawn upon work from masculinity studies in an attempt to show some of what is available. Drawing upon the concept of hegemonic masculinity and its associations with multiple masculinities, this section will briefly, and by necessity, arbitrarily, cast an eye over a few IS-related examples to give a flavour of the potential insights that might be gained.

Within the context of work, probably the major focus for IS research in general, the most obvious area for attention is men's dominance of the IT sector and the consequent association of IS with men's work. Drawing upon masculinity studies might, for example, lead to considerations of who, if anyone, meets the current hegemonic masculinity in the industry. What I mean here is that it would be worthwhile identifying what constitutes the ideal-type masculinity that dominates the lives of those who work in IT and the coping strategies they employ in response. This further raises the question of how the contradictions between any given hegemonic masculinity and competing lesser masculinities (those that are gay or disabled, for example) are managed to secure an identity. Moreover, it suggests a need for inquiry about the relative positioning of masculinities and their relation to technology at work. For example, in the same way as some sol called women's technologies, such as the domestic landline telephone (Lohan, 2001), are seen as lesser in status than more masculine ones, some masculine technologies and the roles associated with them might be relatively positioned to others. Indeed, it has been argued that IS development is perceived as being at the frontier whilst maintenance is viewed as menial, dull work (Swanson & Beath, 1989). In a recent study, for example, it was reported that women still appear to predominate in such low-status roles as maintenance and reporting whether they are new entrants or highly experienced (Dattero & Galup, 2004). Of course, some men may also have to undertake these roles given the lack of women in the industry overall, so it would be interesting to see how their masculinities are managed where they do so. For instance, it has been argued that IS development is particularly amenable to contradictions in masculinity. Knights and Murray's (1994) study of masculinity in software development illustrates that the role is simultaneously presented as requiring an objective, logical, project-focused approach, but one that also relies upon what they call a much-celebrated "'gung ho' form of 'macho' masculinity" (p. 125). From an end-user perspective, there is also the question of where ICTs and IS-based technologies sit in relation to masculinities when other technologies, which are deemed more masculine than ICTs, are used as part of the job. For example, within the U.S. Navy, supply officers who usually undertake administrative roles are seen as weaker because they control people and IS rather than a jet or ship (Barrett, 2001). Finally, the links made between masculinities and technology, as discussed above, are not reserved for developers: A few studies have pointed to this in relation to the adoption of software. For example, Adam and O'Doherty (2000) talk of how at one organisation, a particular piece of technology was adopted "to show the big boys" (that is, to show off to those in larger organisations), and Light (2005) singles out bravado as a shaping influence in the process of adoption. However, those on the receiving end of new technologies that have been adopted may find themselves on the back foot as they are inextricably associated with existing computer-based systems. The problem here is that in order to make way for the new technology, existing arrangements have to be problematized or deligitimised. This usually means that a story is constructed about how they are failing to perform. Thus, in order to preserve some sense of masculinity and save face, users might reconstruct their identities based on discourses around succeeding in getting failing technologies to work, while others might not (Alvarez, 2001). Indeed, there are similarities between some of Alvarez's findings and those of Thorsby and Gill (2004), who report on how men constructed their experiences of in vitro fertilization (IVF) technology in a way that did not undermine their identities as fertile men.

In wider society, the idea of multiple masculinities might be used to consider how marginalised masculinities shape and are shaped by ICTs and IS. For example, on the fringes of IS, there have been a few studies that consider gay men; but whilst representing a further unpacking of masculinity, they do not draw upon the masculinities-studies field. For example, in one UK report, gay men are treated as a homogenous promiscuous group who cannot live without the supporting tools of the mobile phone and Internet chat rooms (Anderson et al., 2002). In another more rigorous study of gay and lesbian Taiwanese (mostly student-based) communities, this stereotypical view is challenged with Internet chat rooms being seen as a useful political device (Yang, 2000). However, multiple masculinities are not really discussed. Thus, these studies miss what I would term any subhegemonic gay masculinity that dominates the construction of what is masculine and feminine within the gay community, and how technology may be implicated in the shaping of this. For instance, one could take the popular Gaydar community Web site that operates in about 159 countries. Gaydar is a software-enabled, Internet-based community where mostly gay men, and some other groups of men who share a sexual preference for men (such as bisexuals and transsexuals), socialise. The software used to create user profiles is standard in nature and is configured by the user based on drop-down menus, tick boxes, and some freeform text. In configuring the software, the users are essentially configuring a version of their identity based on a mix of masculine and feminine characteristics. Indeed, the way this is configured itself is a representation of this. Thus, for example, users are configured as sexually dominant or submissive, and as enjoying hobbies such as dancing, clothes shopping, car maintenance, or bodybuilding. The profile created can be very detailed and results in the intended and unintended categorisation of the users into groups with identities that are well known within the gay community. Importantly, these groups are subject to interpretation in terms of their associations with a highly personalised view of what it is to be masculine. The mutual shaping of the software and the users on Gaydar ultimately perpetuate these masculinities and their interpretation. Moreover, Gaydar is further shaped and has a wider shaping effect on society as new members join. For instance, the influence of and influence upon those who are discovering their sexuality, know where they stand and have just found Gaydar, or want to extinguish it through online abuse such as cyberstalking all play a part. Indeed, the site is, in some ways, representative of (white, upper and middle-class) male dominance in wider Western society. Gay men are still men, and Gaydar is for men. The community's name, Gaydar, would have you believe this might involve gay women, too—this is not the case. As Adam (2005) states, "we talk of football and women's football, not men's football and women's football" (p. 7). My earlier argument that gender still works favourably for marginalised men, such as those who are gay, finds support here. There are gendered versions of Gaydar, for example, http://www.gaydar.co.uk and http://www.gaydargirls.co.uk. Gay men are the default option; women get singled out as different and arguably lesser individuals, and are bolted on as an afterthought.

CONCLUSION

Gender is a social construction that is used to construct and maintain inequalities in society. Yet, despite gender being seen as a relational concept, feminist studies have largely, some would say quite rightly, neglected to theorize masculinity. This is further in evidence in the literature relating to gender and technology, and gender and IS despite agreement with Wajcman's (1991) view of the realm of technology being deemed masculine. With this in mind, I have attempted to show how a more thoroughgoing theorization of masculinities, especially with a focus on those that are marginalised by hegemonic masculinities, might yield interesting insights into the gender-technology relation.

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KEY TERMS

Emphasized Femininity: That which is created and supported to ensure compliance with and complicit affirmation of the hegemonic masculinity at any given time.

Hegemonic Masculinity: Drawing upon Gramsci's hegemonic domination, it is concerned with the idea that a particular definition of masculinity is culturally exalted and latently imposed upon those in society through collective construction and institutional application.

Masculinity: Often recounted as the way men behave, and see and think about themselves. However, more sophisticated views recognise it as a socially constructed category including such characteristics as aggression and technical capability, which are not biologically determined and thus are capable of being held by men and women.

Sexed Regime: A prevailing order of gendered categories such as men and women.

Sexuality: An expression of sexual interest and preference.

Sexual Regime: A prevailing order of identities and practices related to sexuality categories such as gay, bisexual, and straight.

Subhegemonic Masculinity: A masculinity that may dominate a specific group of masculinities within a given wider society. This submasculinity may also refer to the hegemonic masculinity, but it is subordinated by it.

Third World Feminist Perspectives on Information Technology

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INTRODUCTION

Historically, information systems (IS) researchers have conducted empirical studies of gender and information technology (IT) in business organizations. These studies cover a wide range of topics such as the under-representation of women in the IT workforce (von Hellens, Nielsen, & Trauth, 2001) and the educational pipeline, which prepares women for careers in computer-related fields (Camp, 1997; Symonds, 1999). IS researchers have generally embraced an essentialist approach to examine gender differences in the adoption and use of IT (Gefen & Straub, 1997; Venkatesh & Morris, 2000), career selection (Joshi & Kuhn, 2001; Nielsen, von Hellens, Greenhill, & Pringle, 1998), employment experiences (Gallivan, 2003; Sumner & Niederman, 2002; Sumner & Werner, 2001), and employment outcomes (Baroudi & Igbaria, 1997). More recently, however, researchers have adopted anti-essentialist stances and extended IS gender studies to include individual differences among women (Trauth, 2002; Trauth, Quesenberry, & Morgan, 2004), as well as race and ethnicity (Kvasny & Trauth, 2002; Tapia & Kvasny, 2004; Tapia, Kvasny, & Trauth, 2004).

In this growing body of scholarship, a few researchers have argued persuasively for the inclusion of feminist epistemologies in IS research (Adam & Richardson, 2001; Henwood, 2000; Kvasny, Greenhill, & Trauth, 2005). These proponents contend that feminist epistemologies provide theoretical and methodological insights for studying gender as a complex and multidimensional construct for understanding the use, management, and regulation of IT in multiple domains such as business organizations, households, reproductive health, built environments, and the military (MacKenzie & Wacjman, 1991; Ormrod, 1994). Feminist scholars have also called for research that considers not only gender, but also the intersection of racial, ethnic, and class identities (Kvasny, forthcoming).

In this article, we adopt a third world feminist perspective to examine perceptions of IT held by black women in Kenya and the U.S. In what follows, we defining third world feminism, especially as it relates to women in the African Diaspora. Next, we discuss our research methodology, which consists of interviews with women in both settings. We conclude by presenting our findings and implications for future research.

BACKGROUND: THIRD WORLD FEMINISM

The term “third world” captures the discourse that typifies women of color from around the globe as an oppressed group having relatively less formal education, higher birth rates, and lower incomes. These discourses generally employ “emblems of oppression”, that is, the use of single practices such as foot binding in China, veiling in the Middle East, and female circumcision in Africa as emblematic of the totality of women’s experience in a particular culture. In doing so, women’s experiences are collapsed into a single, “victimizing practice” which ignores the multiplicity of ways in which these practices are experienced by women and the ways in which women exercise their agency (Lorde, 1985).

Third world also carries the connotation of colonized populations located in geographically distant nation-states under the economic and political control of so-called developed nations in the West. However, women of color in Western contexts have embraced a third world identity by applying the term "third world" to themselves and their politics to call attention to similarities in locations of, and problems faced by, their communities and communities in third world cultures (Narayan, 1997). It is a call for feminism without the boarders of socio-economic class, race, ethnicity, nationality, and sexual orientation. To silence the voices of diverse women is to deny the opportunity to realize the connections as well as the differences among women. It constructs women of color as voiceless victims who are spoken about and constructed by privileged women in the academy. It is unfair to merely assume that working-class women, middle-class women, lesbians, women in developing countries, and women of color share a common oppression based upon a shared gender. This colonialist stance, according to Narayan (1997), replicates the problematic aspects of Western representations of third world communities, and thus poses an obstacle to the need for feminists to form communities of resistance.

For Smith (1981), "Feminism is the political theory and practice to free all women: women of color, working-class women, poor women, physically challenged women, lesbians, old women—as well as white economically privileged heterosexual women. Anything less than this is not feminism, but merely female self-aggrandizement." Much of the gender and IT research has been about the under-representation of highly paid, college educated women employed in the primary IT sector. There are relatively few IS studies which employ an anti-essentialist epistemology for the study of the lived experiences of economically disadvantaged women of color engaging with IT to improve their life chances (Kvasny, forthcoming).

RESEARCH APPROACH

To gain a third world feminist perspective on IT and to understand what specific differences IT has made socially, politically and economically for black women, we interview 40 black female participants in IT training programs in the U.S. (8) and Kenya (32). The women in the U.S. were participating in a community technology center located in an inner-city neighborhood. The women in Kenya were enrolled in IT bachelor's degree program at a university. These training programs provided women with their initial entrée into the domain of IT.

Using Cameron's (1992) notion of empowering research, we conducted interviews to understand their motivations for participating in their respective IT programs, and expectations for outcomes resulting from this training. In what follows, we focus exclusively on the women's motivations for participating in IT training programs by recounting the common themes which emerged from their narratives.

FINDINGS

Even though women in Kenya have traditionally been active in the informal economies around agriculture and local trade, and the women in the U.S. had limited formal educations and held low-paying jobs in the service sector, they both perceived IT as a panacea for acquiring desirable job skills and employment that would lift them out of poverty. For instance, nearly one-half of the women in Kenya participated in the IT educational programs because they perceived substantial job opportunities upon graduation. The IT sector was described as "an upcoming field," and as "a new field in Kenya and a very dynamic field which affects all aspects globally." They also believed that there were few IT professionals and therefore skilled people have a competitive advantage. One woman remarked that "not many people in Kenya have this sort of information [and] this is because currently in Kenya there lacks professionals in this field." Not only were there "job opportunities that come with this vast growth," the jobs were seen as well paying. "I think IT is a field that will provide me with a means of earning good income in future." "IT program have proved to be better paying careers than other technical careers in the country."

Many Kenyan women remarked specifically about acquiring skills which would enable them to integrate IT into business organizations. For instance, "the integration of business in the IT program made it even more attractive for me." "This course is not a technical course. I am not interested in details about technologies…I am interested in how I can use IT more efficiently and a broader view." U.S. women mirrored this belief about leveraging IT skills in the workplace. "I will learn a lot of computer applications when I finish this class. I will be able to get a better job and better opportunities. I will conquer the digital divide. We all need to learn these computer applications. We will need this information to be successful in the business world."

Some women were more entrepreneurial, and saw IT as a way to start their own business. "Since I have the basics of IT and my course provides a grounding I can build up on my own, I could start my own enterprise using this knowledge." For some Kenyan women, business ownership was once a dream that now can potentially be achieved. "Given that I would like to learn IT so that I run my own IT firm in future. If I do not take this chance to learn IT, then my dream will not be accomplished."

We also found that the American narratives were not about gradual movement; they were about rapid escape from oppression and positive outlooks on the future. "I have certainly had a successful computer orientation and beginning. It is truly an exciting journey. My goal is to continue my training with the ultimate goal focusing on certification status. Then, it is look out world as I am on my way!"

Kenyan women, in particular, were motivated by perceived gender inequalities. For them, IT offered an opportunity for overcoming oppression and achieving parity with men. "Gone are the days when there were specific jobs/careers for men and women. Women now want the challenge." "More and more women want to play an active role in their society and in the world…women want to be involved in the IT sector (not to be left behind by their male counterpart)." IT represented a vehicle which would enable them to engage in an activity which has been historically perceived as a male domain. "The simple reason why women participate in this IT program is because men do the same thing. Equality is something that women have all been fighting for and have accomplished their goal. If a man can participate in IT, why shouldn't a woman do the same thing?" Women not only want to do the same thing as men, they want to adopt IT "because it is beneficial to them too as much as it is to men… it will enable us as women to compete fully with men in jobs."

Women in both countries believed that women in IT-related professions are "able to successfully represent other women in our country" and "able to adapt to contribute to society by raising awareness about what IT can do for a nation." Thus the training provided immediate benefits to the recipient, but also external benefits to other women and the entire nation. These were pioneering women who were not content to "stick to the stereotype that certain jobs are for women." They wanted to demonstrate that "they are clever enough to prove that they can master a tough course like IT and do well."

African-American women didn't speak of gender inequities, but they did speak of community solidarity. "[W]e are taking computer classes that have connected us with the great information divide. We are no longer left behind … We are still traveling on the road of information freedom and enjoying every minute of it. There is so much to be learned, and the information is available because we made the first step, receiving information and taking the steps to change our future in the usage of the computer in our everyday life. We now realize that the Internet is the mode of travel for today as well as tomorrow." This woman often uses communal words like "we", "our" and "us" to signify the collective advancement of working-class people in her neighborhood. The sense of freedom and inclusion is important as it signifies a break from the isolation expressed by inner city residents.

FUTURE TRENDS AND CONCLUSION

In an IS discourse community comprised of scholars working primarily from a western European frame of reference, what can a third world feminist perspective offer to the scholarly discourse about gender and IT? Third world feminism provides a lens for analyzing the oppression faced by women of color, and the perceived role of IT in alleviating inequities. This oppression comes not only from gender, but also from race, ethnicity, poverty, and institutional policies that limit their human agency. These factors are interwoven, which clearly suggests the need for scholarship that provides a more nuanced understanding of women's issues and IT.

The women in this study saw IT as a mechanism for gaining access to other people's privileges. Notably, the two words "market" and "job" dominate the women's narratives, which hint that those women are still on the level of satisfying their most basic needs, and are seeking employment opportunities for improving their life chances. When examining employment, it is important to consider that jobs provide more than economic ends. Jobs also provide a sense of belonging to society and to a profession. Employment can improve self-esteem, feelings of accomplishment and independence, as well as provide access to healthcare and education.

The women were also attracted by these programs because popular discourses tend to romanticize IT and lull people into believing that practical computing skills are easily translated into high paying jobs. Here practical can be translated into skills desired by employers. Some women even mentioned directly that "it will guarantee an instant job." Thus, the job market was seen as highly elastic for people with marketable IT skills. Women in both settings greatly privileged hands on training and frowned upon theoretical learning because practical training could be more readily converted to marketable skills.

Given the pervasive history of racial and gendered oppression, women across the African Diaspora have limited mechanisms for representing and demonstrating the fullness of their abilities, aspirations, and accomplishments. These women did, however, generate self-defined perspectives which grew out of their struggle to appropriate IT. The dominant discourse of IT as a mechanism for empowerment and increased workforce participation resonated with the women's deep and justifiable frustrations. Even though they suffered, they believed that IT presented a real opportunity for change.

Gender-as-variable studies which measure differences in IT adoption, use, and employment do little to enact social change; they simply measure the status quo. IS researchers should therefore adopt a feminist or other gender-as-relations approaches to understand the situated nature of IT as experienced by diverse women, and enact praxis oriented methods such as action research and participatory design techniques to create socio-technical interventions that enable women to realize their economic, cultural and political potential. Then, perhaps, third world women can fully realize other people's privilege.

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KEY TERMS

Anti-Essentialism: The belief that while there are biological differences between men and women, gender is not a biological matter; it is a social construction used to create and perpetuate systems of privilege. The term woman (feminine, weak, submissive), for instance, is socially constructed as a binary opposite from the term man (masculine, strong, assertive).

Essentialism: Essentialism is the belief that women are biologically different from men, and that this biological difference has implications for the ways that we think and act.

Feminism: Feminism is a set of social theories and political practices that are critical of past and current social relations which privilege men as a group. Feminism involves the promotion of women's rights, and the belief that men and women should be politically, economically, and socially equal.

Gender as Relation: This is an anti-essentialist view in which women are believed to have unique experiences. The research aim is not to compare men and women, but rather to center women's needs, behaviors, ways of thinking, and experiences.

Gender as Variable: This is an essentialist view in which gender is seen as an objective, often quantifiable, demographic variable. Women are perceived as a single group with common needs, values, and behaviors. Women are generally compared to men to demonstrate gender differences.

Third World Feminism: Third world feminism is a critical set of theories and political practices which gives voice to the issues of women of color from diverse socio-economic class, race, ethnicity, nationality, and sexual orientation. Third world feminism challenges to mainstream feminism have highlighted the ways in which issues central to the lives of women of color have been misrepresented or rendered invisible, and have demanded recognition of the global imbalances in which mainstream feminist agendas are structured.

UN World Summit on the Information Society

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INTRODUCTION

The World Summit on the Information Society (WSIS) is a United Nations (UN) conference led by the International Telecommunication Union (ITU). It has unique structural features. First, WSIS is comprised of two summit events: one in Geneva, Switzerland, December 10 to 12, 2003, and the other in Tunis, Tunisia, November 16 to 18, 2005. Second, WSIS is characterized by the so-called multistakeholder approach (Association for Progressive Communications [APC] & Campaign for Communication Rights in the Information Society [CRIS], 2003; Hemmati, 2002; Raboy, 2004). In this approach, civil society and the private sector have an institutionalized basis in the summit process from which to engage with governments and inform the political deliberations. The goal set for WSIS is to develop a global consensus on the features that are to characterize the information society and on ways to bring this society about.

BACKGROUND

Historically, WSIS is part of the unprecedented series of UN conferences and summits that have in particular marked the 1990s and early 2000s. These conferences have taken up pressing issues such as sustainable development and the environment, human rights, women's rights, the abolition of racism, and poverty eradication, and have discussed them within a global framework. The impetus to hold a World Summit on the Information Society came from ITU, which adopted a resolution to this effect at its Plenipotentiary Conference in 1998 (Resolution 73; Minneapolis). When the UN General Assembly finally took up this issue and adopted it in 2001 (A/RES/56/183), much of the attention within the UN had already shifted to the Millennium Summit and its follow-up process, particularly the Millennium Development Goals (MDGs). The ongoing WSIS political process, which culminates in 2005 with the Tunis summit, has been eclipsed by this focus to the effect that the UN Millennium Summit +5 (September 14 to 16, 2005) is now termed the 2005 World Summit.

THEMATIC SCOPE OF WSIS

Thematically, WSIS has focused almost exclusively on the new digital and networked information and communication technologies (ICTs) so that the prime developmental question has been how to bridge the digital divide. Given the importance attached to the Millennium Summit follow-up, this question has in the WSIS process been tied to the assertion that ICTs can and should be employed for reaching the goals laid down in the Millennium Declaration. A major point of political contestation has been which financial mechanisms could be utilized in this respect, from the exploitation of existing development cooperation favored by the North to the establishment of a new digital solidarity fund called for by the South. Further main issues of the political debate, whose discussion has not necessarily stood in relation to the question of how to enable development and a sustainable closing of the digital divide, have been the scope and organization of Internet governance; human rights including freedom of expression and communication rights, as well as the right to privacy vs. national security issues; intellectual property rights (IPRs) vs. knowledge commons and public resources; proprietary vs. free- and open-source software models; and media diversity vs. media monopolies.

GENDER DIMENSIONS IN TERMS OF THE WSIS POLITICAL OUTCOME

The principle of gender mainstreaming has not been applied to WSIS, and the political deliberations have hence been characterized by a gender-blind and male-centered discussion process. A broad reaffirmation of women's human rights and of the commitment to women's empowerment and gender equality has been hard to achieve and has not automatically extended from the first to the subsequent political statements that have been discussed: the Declaration of Principles (WSIS-03/GENEVA/DOC/4-E) and the Plan of Action (WSIS-03/GENEVA/DOC/5-E) that were agreed upon at the Geneva Summit, and the Political Chapeau and Operational Part that are currently negotiated for the Tunis Summit. The one strong commitment to women codified so far is Paragraph 12 of the Declaration of Principles. It states,

We affirm that development of ICTs provides enormous opportunities for women, who should be an integral part of, and key actors, in the Information Society. We are committed to ensuring that the Information Society enables women's empowerment and their full participation on the basis on [sic] equality in all spheres of society and in all decision-making processes. To this end, we should mainstream a gender equality perspective and use ICTs as a tool to that end. (United Nations, 2003a)

In addition to this paragraph, two more paragraphs of the Declaration of Principles contain expressly gendered content: Paragraph 2 reiterates the promotion of gender equality and the empowerment of women as well as the improvement of maternal health as goals of the *Millennium Declaration*, toward which ICTs should be employed. Paragraph 29 refers to the special needs of girls and women regarding literacy and universal primary education.

In the Geneva Plan of Action (PoA, United Nations, 2003b), several paragraphs take up specific concerns of girls and women, while it is indirectly claimed that "special attention will be paid" to girls and women with respect to all objectives, goals, and targets of the PoA (para. B.7). Explicitly, the PoA addresses girls' and women's promotion with respect to ICT education, training, and careers (paras. C4.11.g, C7.19.a, C7.19.c, C7.19.d, C8.23.h, C6.13.l); the integration of a gender perspective in ICT education (para. C4.11.g); a focus on "gender-sensitive curricula in formal and non-formal education"; and the attainment of "communication and media literacy for women" (para. C8.23.h) as well as the promotion of balanced and diverse media portrayals of men and women (para. C9.24.e). Also, the need to acknowledge "women's role as health providers in their families and communities" is referenced in the context of e-health (para. C7.18.e). Importantly, the PoA acknowledges the requirements to monitor the developments and to devise "gender-sensitive indicators on ICT use and needs" (para. E.28.d).

GENDER DIMENSIONS IN TERMS OF THE WSIS PROCESS AND ENTITIES

The larger WSIS process has constituted a unique focal point and has even been a catalyst both for research on women, media, and ICTs, and for feminist advocacy regarding media and ICT that is based on this research. Various stakeholder entities from inside and outside the UN system have been involved in these endeavors and have promoted them in the WSIS process. Important examples from within the UN system during the Geneva phase are the following. The UN International Research and Training Institute for the Advancement of Women (INSTRAW) held a virtual seminar series on gender and ICTs in the summer of 2002 (Huyer & Sikoska, 2002). The same year, the UN Division for the Advancement of Women (DAW), together with other agencies, held two expert group meetings and two online discussions in preparation for them. One meeting was titled Information and Communication Technologies and their Impact on and Use as an Instrument for the Advancement and Empowerment of Women and was held in Seoul, Republic of Korea, November 11 to 14, 2002 (DAW, 2002a). The other was entitled Participation and Access of Women to the Media, and the Impact of Media on and its Use as an Instrument for the Advancement and Empowerment of Women and took place in Beirut, Lebanon, November 12 to 15, 2002 (DAW, 2002b).

The 47th session of the UN Commission on the Status of Women (CSW) in 2003 brought many of the previous findings together under the agenda item Participation and Access of Women to the Media, and Information and Communications Technologies and their Impact on and Use as an Instrument for the Advancement and Empowerment of Women (New York, March 3 to 14, 2003). By submitting its agreed conclusions (CSW, 2003) to the WSIS process, CSW built a bridge between its task to follow up on the Twelve Critical Areas of Concern codified at the Fourth World Conference on Women in Beijing, China, in 1995, and the then current WSIS negotiations. The UN Inter-Agency Network on Women and Gender Equality (IANWGE) additionally brought together the assessments of many other UN bodies and produced fact sheets on ICTs and women to inform the WSIS debates.

Feminist advocacy during the Geneva phase was characterized by two entities, which in the Tunis phase have merged into one. The WSIS Gender Caucus was formed in the summer of 2002 and has been working since. It mirrors the multistakeholder approach of WSIS itself and is open to all gender-equality advocates, from governmental ones to business and civil-society ones. The Gender Strategies Working Group (Non-Governmental Organizations' NGO # GSWG), which came into being shortly after the WSIS Gender Caucus, was only active during the Geneva phase. As the name implies, it was a civil-society entity. Both groups were instrumental in achieving the recognition of gender issues and accomplishing the codification of the gender-equality provisions and special measures for girls and women cited above. Early governmental motions in this direction, which were only put forth by a few countries such as Canada and South Africa, were overruled up until the negotiations in September 2003.

The WSIS Gender Caucus, the NGO GSWG, and their membership organizations made extensive use of the exposition ICT4D (ICT for Development) held in conjunction with the Geneva summit: They showcased a substantial number of ICT-for-women initiatives and presented a multitude of panels, seminars, and workshops on women and gender in the information society. The NGO GSWG also provided substantial input on women's rights and gender equality to the civil-society declaration that was adopted at the Geneva summit, entitled *Shaping Information Societies for Human Needs* (Civil Society Declaration to the World Summit on the Information Society, 2003).

FUTURE TRENDS

At the time of this writing, the outcome of the Tunis summit is still open, as are the kinds of implementations and follow-up processes that will characterize the post-Tunis phase. It is to be expected that most of the post-Tunis political discussions, planning, implementation, and evaluation will be conducted on the regional or subregional levels. On these levels, many of the research findings about women, media, and ICTs that have been brought together or generated in the WSIS context can be applied. These encompass broad overviews (Gurumurthy, 2004; Kuga Thas, Ramilo, & Cinco, in press; Primo, 2003) and applications of fundamental principles such as human rights (Jensen, in press) as well as sector-specific approaches. The latter include ICT policy and regulation as a central area of feminist concern since the late 1990s (Hafkin, 2002; Jorge, 2000). They also encompass questions of women's participation in e-democracy (Martínez & Reilly, 2002; Ramilo, 2002) and in the economy, as well as girls' and women's needs and opportunities in sectors such as e-education and e-health.

CONCLUSION

The WSIS process has been a focal point and catalyst for gender-sensitive research on media and ICTs in all world regions and a center of advocacy with respect to gender equality, nondiscrimination, and women's empowerment in the information society. As such, it has not only brought back to the global agenda the issue of women and media, which constitutes one of the Twelve Critical Areas of Concern of the Beijing Declaration and Platform for Action, adopted at the Fourth World Conference on Women in Beijing in 1995. It has also broadened the scope of this area of concern to encompass gender dimensions of new pressing issues, from free- and open-source software models to Internet governance. It has hence achieved what the Beijing +10 review process, which culminated in the 49^{th} session of CSW in February and March 2005, failed to achieve: an acknowledgment of the tremendous impact of media and ICTs on women's and girls' lives in the current processes of global restructuring, and hence of the need to carefully engineer these ICT-driven processes from a gender-equality point of view. It is true that the political outcomes of WSIS do not provide a comprehensive set of tools in this regard. But the fundamental commitment to gender equality and women's empowerment that was laid down in the WSIS *Declaration of Principles*, together with the acknowledged need to provide special measures for girls and women and to develop gender-sensitive indicators on ICT use and needs, can and should be employed to shape the WSIS implementation phase and thus the information society itself in a more just and sustainable manner.

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KEY TERMS

Beijing Declaration and Platform for Action: The outcome document of the Fourth World Conference on Women, held in Beijing in 1995. It constitutes a comprehensive analysis of the areas in which women's and girls' human rights are violated, and outlines wide-ranging actions to counter this situation in order to empower girls and women and to achieve gender equality. Among the Twelve Critical Areas of Concern codified in Beijing is one entitled Women and the Media. Two strategic objectives are elaborated in this context. One is to "[i]ncrease the participation and access of women to expression and decision-making in and through the media and new technologies of communication" (United Nations, 1995: strategic objective, p. 1). The other is to "[p]romote a balanced and non-stereotyped portrayal of women in the media" (United Nations, 1995: strategic objective, p. 2).

CEDAW (the Convention on the Elimination of all Forms of Discrimination against Women): Adopted by the UN General Assembly in 1979 and entered into effect in 1981. It constitutes the most comprehensive human-rights instrument in existence for women. In its preamble and 30 articles, CEDAW defines discrimination and maps a broad agenda for governments to end discrimination de jure and de facto in all spheres of society. Over 90% of the member countries of the UN are by now parties to CEDAW, with the notable exception of the USA. While CEDAW does not address media in depth, its provision to counter stereotyped roles of men and women and the social and cultural patterns that perpetuate these roles (Article 5a) has lent itself well for an application in the field of media and ICTs, both with respect to media content and with respect to occupational segregation in the media industries. This illustrates that CEDAW is a living convention whose provisions have been adaptable to diverse and changing circumstances.

Millennium Development Goals (MDGs): The time-bound and quantified targets for combating extreme poverty in several dimensions that came out of the UN Millennium Summit of 2000. There are eight goals: (1) eradicate extreme poverty and hunger, (2) achieve universal primary education, (3) promote gender equality and empower women, (d) reduce child mortality (4) improve maternal health, (5) combat HIV, AIDS, malaria, and other diseases, (6) ensure environmental sustainability, and (7) develop a global partnership for development. Within WSIS, Goal 8 is interpreted as a call for the use of ICTs in order to facilitate the achievement of all other goals.

Multistakeholder Approach: A form of political deliberation, and sometimes also decision making, that first identifies the individuals and groups who have a stake in the outcome of certain negotiations, and then brings them together to develop solutions. It is expected that multistakeholder processes lead to well-informed and well-balanced decisions, and that the process of developing these creates trust and commitment among the stakeholders that impacts favorably on the implementation process. In WSIS, the main stakeholder groups are representatives of governments, civil society, and the private sector. These groups, however, do not participate on an equal footing, and decisions are entirely up to the governmental representatives.

NGO Gender Strategies Working Group (NGO GSWG): The civil-society entity that promoted gender equality and the participation of women during the Geneva phase of the WSIS process. Its seven priority issues for gender equality were (1) to take an intersectional approach, (2) to build on the global consensus from previous UN world meetings, (3) to focus on people-centered development, (4) to involve a human-rights framework of analysis, (5) to uphold respect for diversity, (6) to uphold peace and human development, and (7) to support local solutions. Like most other civil-society groups, the NGO GSWG was largely self-financed. It was formed at the first WSIS Preparatory Committee Meeting in Geneva in July 2002. Its initial members were African Women's Development and Communication Network (FEMNET), Agencia Latino Americana de Información, the Association for Progressive Communications Women's Networking Support Program (APC WNSP), the International Women's Tribune Centre (IWTC), and Isis International-Manila.

UN Commission on the Status of Women (CSW): A functional commission of the Economic and Social Council established as early as 1946 to promote the equal rights of women and men. In the wake of the Fourth World Conference on Women in Beijing in 1995, CSW was additionally mandated to conduct the follow-up process to that summit and to mainstream a gender-equality perspective within the UN. In 1996 and again in 2003, CSW reviewed issues concerning women and the media. CSW consists of 45 members who meet for 10 days each year.

WSIS Gender Caucus: A multistakeholder group that has promoted the principles of gender equality, women's empowerment, and women's human rights as well as the participation of women in the WSIS process. It operates with financial assistance from Finland, Norway, Denmark, Sweden, and the UN Development Fund for Women (UNIFEM). The WSIS Gender Caucus was formed at the invitation of UNIFEM in 2002 at the African regional preparatory conference in Bamako, Mali, May 25 to 30. The founding members include Abantu for Development; African Centre for Women, Information, and Communications Technology (ACWICT); African Connection Programme; African Information Society Gender Working Group (AIS-GWG); Women's International Netowork of the World Association of Community Radio Broadcasters (AMARC-WIN); AMARC Africa; Association for Progressi ve Communications Africa Women's Programme; AQ Solutions Association of Yam-Bukri; Environment and Development Action (ENDA); Gender Equity and Equality Project (GEEP); FEMNET; Media Institute of Southern Africa (MISA); Network for the Defence of Independent Media in Africa (NDIMA); Network of African Women Economists; United Nations Development Programme Sub-Regional Resource Facilities West Africa (UNDP/SURF West Africa); UNIFEM; Unite d'appui au programme de la cooperation Canada-Malienne; WomensNet South Africa; Women of Uganda Network (WOUGNET); Zimbabwe Women's Resource Centre and Network (ZWRCN); and the Zimbabwe Ministry of Transport and Communications. By now, the WSIS Gender Caucus has more than 100 registered participants on its Listserv, representing all stakeholder groups.

Understanding the Mommy Tracks in the IT Workforce

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INTRODUCTION

Despite the recent growth in the number of women in the American labor force, women are under represented in the IT workforce. Key among the factors that account for this under representation is balancing work-family issues. Some researchers have speculated that IT work is not an ideal fit for working mothers because of long work hours, increased conflicts with family responsibilities, and the difficulty of returning after maternity leave to an industry with ever evolving technologies (Kuosa, 2000; Webster, 1996). This article reports on an empirical study that explored the influence of work-family balance on American women's participation in the IT workforce by using the Individual Differences Theory of Gender and IT (Trauth, 2002; Trauth, Quesenberry, & Morgan, 2004; Trauth, Huang, Morgan, Quesenberry, & Yeo, 2006). In doing so, we summarize a work-family balance study presented in greater detail in Quesenberry, Morgan, and Trauth (2004) and Quesenberry, Trauth, and Morgan (2006) that articulates the ways in which individual and environmental factors influence female responses to issues of work-family balance.

BACKGROUND

Studies of the IT workforce are mixed on the question of whether the IT workplace is a conducive or an unfriendly environment for working mothers. One stream of research points to the IT industry as having a pragmatic approach to working practices that can have a positive impact on working mothers. These practices include innovations in teleworking, job-sharing and technical advances that allow more flexibility in work-family balance (Quesenberry & Trauth, 2005; Zimmerman, 2003). An alternative stream of research highlights several difficulties associated with work-family balance in the IT workforce. Trauth's studies in Ireland and Australia revealed that women found it difficult to manage work-family conflicts despite shifts in societal views about working mothers (Trauth, 2002; 2000; 1995; Trauth Nielsen, & von Hellens, 2003). Webster (2002) adds that this is "particularly hard to reconcile with the working rhythms of IT work" (p. 6) and may not be conducive for many women.

Researchers also highlight the consequences associated with work-family balance for women in the IT workforce. Mennino and Brayfield (2002) found that female employees in male-dominated occupations make more family trade-offs and fewer employment trade-offs than employees in other occupations. Ahuja (2002) reports that women may have to neglect certain family obligations to be eligible for promotional opportunities similar to those of men. Baroudi and Igbaria (1994) point to family-related responsibilities as partial explanation for the under representation of women in managerial positions. Likewise, Sumner, and Werner (2001) found the burden on family-career balance from overtime and administrative tasks to be a barrier to women in management.

MAIN THRUST OF THE ARTICLE

This article reports on one aspect of a multi-year, multi-site qualitative field study of women working in IT whose goal is to investigate the female under representation in IT. Our objective is to contribute to a deeper understanding of specific factors that influence American women in their working lives as IT professionals by examining the work-family balance issues facing women in the IT workforce and how they respond when making decisions about their personal and professional development.

Fifty-seven open-ended, in-depth, face-to-face interviews with female practitioners in the IT workforce were conducted between October 2002 and August 2004. The participants represent a range of geographical locations, ages, demographic backgrounds, educational backgrounds, levels of management and job classifications, relationship statuses and family compositions. The women work and live in three different geographical regions of the U.S.: the Northeast (Boston, Massachusetts), the Southeast (Research Triangle/Charlotte, North Carolina) and the Mid Atlantic (central Pennsylvania). The women range in age from 21 to 58 with the average age being 40.6 years. Furthermore, 35 of the women are married, 2 are in committed relationships, 14 are single and 6 are divorced/not remarried. Thirty-two of the women have one or more child and 26 of the women do not have children.

The guiding theory for this research is the Individual Differences Theory of Gender and IT proposed by Trauth (2002; Trauth, Huang, et al., 2006; Quesenberry, 2004) that focuses on differences among women in the ways they experience and respond to characteristics of IT work, the IT workplace and societal messages about women and IT. This theory focuses on women as individuals, having distinct personalities, experiencing a range of socio-cultural influences, and therefore exhibiting a range of responses to the social construction of IT. Thus, the theory elucidates the differences *within* rather than *between* the sexes and examines issues at an individual rather than a group level of analysis.

Analysis of Work-Family Balance in the IT Workforce

What emerged from the analysis of life histories of women in IT are four categories of women in the IT workforce: the non-parent, the working parent, the "back-on-track" parent and the "off-the-track" parent. The categories are by no means static or limiting. Rather they are dynamic in nature, and were created to analyze data to support theory refinement.

The Non-Parent: Balancing Work-Family Issues without Children

The *non-parent* category is comprised of women employed in the IT workforce who do not have children. The non-parent represents 26 women or 45.5% of the women interviewed. These women are single, married, partnered, and divorced and range in age from 21 to 53, with an average age of 37.8 years. The non-parents consist of two groups of women: women who have *not yet* had children and women who *are not* having children. This is important to note this distinction because not all non-parents are young, single women who have not yet reached a point to have children. Rather, many non-parents are women who have made conscious decisions not to have children.

Despite the range of explanations regarding motherhood, one common theme arose regarding work-family balance: the non-parents acknowledged their ability to more easily balance work-family issues in the IT workforce than their co-workers with children. The non-parents felt that they were more able to adjust to the temporal aspects of IT work, including longer work days and late hours. In addition, many non-parents felt more able to participate in after-hour networking events than co-workers with children. Further, several participants also commented on the freedom they enjoyed by not having to make work-child trade-offs. Although non-parents have chosen to not have children and tend to acknowledge the increased ability to balance work and life, it does not mean that they are all workaholics who are focused exclusively on themselves or their careers. Many of the non-parents talked about their values regarding personal life and time spent away from the office. They spoke of elder care, responsibility for nieces and nephews, other family commitments and pets.

Another theme raised by the non-parents is coping with the societal message they sometimes received about motherhood. This was explored through discussion of regional cultural attitudes towards women and women working. Many non-parents spoke about a cultural message that women's family obligations should take precedence over professional obligations. Thus, they should assume domestic child-care roles and men should assume professional income-earning roles. According to this view, the only acceptable jobs are domestic or traditional female occupations. Francie, a 26 year-old software engineer, summarized this message by explaining:

Typically, the family obligations take precedence over the professional obligation. ... I think typically [the societal view] is, that, when the woman has a child that she should stay home and take care of them. The male would be the financial supporter [Francie].

From a personal development perspective, the non-parents spoke about the difficulties reconciling their own identities with what they perceive to be a societal stereotype of women. For instance, Nancy, a 48 year-old Web consultant, spoke about the pressures she felt to have children despite the fact that it conflicted with her own personal desires. The women also spoke about the difficulties reconciling their professional development with views of women working. The non-parents also spoke of the difficulties reconciling their professional development, particularly in job attainment, with a socially constructed view of women as primarily mothers. Many non-parents discussed the difficulty they faced in obtaining IT jobs because of attitudes towards women working in IT.

The Working Parent: Balancing Work-Family Issues Concurrently

The *working parent* category is comprised of women who have both children and a career in IT. The working parent represents 26 women or 45.5% of those interviewed for this paper. Working parents are women who do not fit the working parent dichotomy found in the literature because they place a value on both family and career. Working parents represent a range of ages and relationship statuses including single, partnered, married, and divorced. Furthermore, the working parents represent a range of motherhood scenarios including raising one or more child (biological, adopted, and foster), and vary in age from 27 to 57 years old.

The working parents are typically motivated by both financial and personal desires to simultaneously work and raise their children. Although, these women acknowledge the financial benefit of working in IT, an overwhelming sentiment is that they seek employment because of the personal value they place on being active and continuing to grow as a professional. Donna, a 39 year-old quality assurance analyst, was asked how important work was in her life:

I think [having a career] is very important for me… It's important to keep my mind active to keep challenged and to like what I do. When I stop having fun at this job that's probably when I'll decide it's time to move on. I think it's very important to stay active [Donna].

Although, many working parents value a professional career, they also acknowledged the difficulties associated with having one. The women frequently spoke about the work-family balance issues that arise, particularly those with regard to the temporal arrangements of IT work such as a 24/7 work day where employees are always accessible. Candace, a 41 year-old systems developer, felt that there is a growing tendency in the last few years for employees to work extra hours and to be "constantly available by computer or phone."

A recurring theme raised by the working parents related to the importance of work flexibility. The women spoke about the benefits of work programs such as job sharing, part-time work and manageable commutes. For instance, Kimberly, a 38 year-old project manager, has the ability to telecommute and was one of the first women at her IT consulting firm to be promoted to manager while on maternity leave. Another prevalent theme expressed by working parents is the importance of supportive partners and spouses. Many working parents spoke about how their partners and spouses share an active role in child rearing, domestic responsibilities, and community volunteer activities.

Several working parents spoke about the societal pressures and mixed messages they receive about raising children and working outside of the home. The participants highlighted the societal messages that women should be stay-at-home mothers. Rose, a 47 year-old director of IT who is Japanese American, explained that her culture puts "a lot of emphasis on the Japanese woman staying home and taking care of the children" and taking on duties such as finances and keeping certain traditions alive. The working parents spoke of the difficulties of reconciling their professional development particularly in getting a job with societal images of women working in IT. They noted the negative stereotypes associated with being a working parent and the influence it had on their careers. To overcome these societal views of women, the working parents shared accounts of having to work harder and longer hours than coworkers, in order to dispel the negative stereotypes of working mothers.

The "Back-on-Track" Parent: Balancing Work-Family Issues Sequentially

The *back-on-track parent* refers to women who, for a variety of reasons, took time away from work to raise children and then later returned to the IT workforce. The back-on-track parents represent 9% or five women interviewed for this paper. The back-on-track parents are older in age, ranging from 44 to 58 with an average age of 50.2 years. All of these back-on-track parents were in committed relationships during their employment break so that the main source of income came from their partners or spouses.

A common theme arising from the back-on-track parent interviews was the idea that women should take time away from work to stay home because it was the right thing to do. This idea seems to stem from societal messages that the women received during their childhood and adult lives. These messages appear to vary by geographical regions included in the study, and the associated cultural influences. Although, Sue, a 53 year-old IT coordinator, from central Pennsylvania eventually returned to work she felt that she was "supposed" to follow the path in life of going to school, getting married and then staying home with kids:

I wound up going to a two year college because I really didn't think that getting into sports was something I was supposed to do. I felt more pressure to go into business and get married and become a secretary or something like that. ... So I went to a two year associate [degree at a] Catholic college and took business, so I got an associate degree in business and then got married, had kids, the whole [thing] [Sue].

Although, societal pressures about motherhood and careers affect women in non-technical and technical careers alike, there is a common shared experience of the back-on-track parents that relates specifically to the IT workforce. This theme relates to the amount of skill preparation required for reentry into the IT workforce. This difficulty of returning to IT work has caused the back-on-track parents to develop plans of action to ease the transition. For instance, Elsie, a 47 year-old website manager, spoke specifically about the amount of "intense" work that was required to reenter the IT workforce. Consequently, she developed a success strategy that involved diligently working to prove herself as a viable employee despite the fact she is ten years older than her cohort.

The stories of back-on-track parents demonstrate that balancing work-family issues in IT work is a constant challenge that pulls women in several directions at once. Societal messages complicate the pressures women feel in decisions about their professional and personal lives. Likewise, long, irregular work hours associated with IT careers makes it difficult to balance work-family issues. Thus, taking time away from the IT workforce is a temporal solution to these conflicts. Leaving the workforce for an extended period of time allows women to balance family responsibilities during the early years of their children's lives and return to their careers at a point in time when their children are more self-sufficient.

The "Off-the-Track" Parent: Balancing Work-Family Issues by Egression

The fourth type of parent is the *off-the-track parent* comprised of employees who permanently leave the IT workforce upon having children. We have not captured data regarding the off-the-track parent because our participants are drawn from women currently employed in the IT workforce. However, for purposes of conceptual completeness we include this category in our discussion.

CONCLUSION

With regard to theory, our research shows that work-family tradeoff considerations are much more nuanced than what is commonly depicted in the literature. Women experience a range of work-family situations that present varying issues and concerns. The remarks illustrate an identifiable theme that crosses geographical regions and timeframes: *societal messages are complex and difficult to digest, and are processed in different ways by different women, yet they contribute to the decisions women make about their professional and personal lives.* More specifically, this research is an example of the application of the Individual Differences Theory of Gender and IT to go beyond the identification of societal messages that operate at the group level to also understand the response variations among women when examining the topic of work-family balance.

Of utmost importance to practice is the realization that not all women, indeed not all employees, have the same work-family balance issues and therefore, do not have the same needs or concerns with regard to their careers. Likewise, we do not advocate special considerations given to any group of individuals as it is highly likely that such a plan of action would weaken these groups in the labor force. Rather, our findings suggest that a more robust and flexible conceptualization of career tracks with multiple avenues would benefit a wider range of IT workers, both men and women, as the traditional view of a career is one that no longer reflects the needs and concerns of workers.

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KEY TERMS

Individual Difference Theory of Gender and IT: a social theory developed by Trauth (Trauth, 2002; Trauth, Quesenberry et al., 2004) that focuses on within-group rather than between-group differences to explain differences in male and female relationships with information technology and IT careers. This theory posits that the under representation of women in IT can best be explained by considering individual characteristics and individual influences that result in individual and varied responses to generalized environmental influences on women.

Interpretive Research: Research directed at understanding the deeper structure of a phenomenon within its cultural context by exploring the subjective and intersubjective meanings that people create as they interact with the world around them (Orlikowski & Baroudi, 1991, p. 5).

Qualitative Research: A term used to describe forms of social inquiry that aim at understanding the meaning of human action and that rely primarily on qualitative data (i.e., data in the form of words), including ethnography, case study research, naturalistic inquiry, ethno-methodology, life-history methodology and narrative inquiry (Schwandt, 2001, p. 213).

Work-Family Balance: the act of balancing inter-role pressures between the work and family domains, which are generally mutually incompatible.

Work-Family Balance Categories: a description of decisions about work-family balance of women in the IT workforce, which is comprised of four types: the non-parent, the working parent, the "back-on-track" parent and the "off-the-track" parent.

Unintended Consequences of Definitions of IT Professional

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INTRODUCTION

Attention to women's low participation in information technology is framed in Canada and elsewhere in terms of concern over availability of well-qualified human resources (ITAC & IDC, 2002) as well as equity issues (Applewhite, 2002; Ramsey & McCorduck, 2005).

In most of these discussions, IT Professional is equated with Computer Scientist or Engineer in spite of the evidence that the profession is more diverse. This article suggests that while those directions are worthwhile, the very definition of "information technology professional" framed in the discourse may have unintended consequences which tend to exclude women. Framed by the literatures on gender and institutionalization of professions, this article applies critical discourse analysis to a variety of "texts" concerning the IT profession in Canada as well as available empirical data. Critical discourse analysis focuses on surfacing the political structures which underlie taken for granted assumptions (Fairclough, 1995). We maintain that while it is critically important to continue to attract females to study computer science and engineering, it is equally important to ensure that multiple paths are available and respected and that narrow definitions are not systemic barriers to the participation of women in the IT profession. In addition, more inclusive definitions which broaden the perspective on information technology (and match the reality of the industry) will promote good technology practices.

BACKGROUND

Women and information technology has been the subject of much attention. Although women account for half the Canadian workforce, they represent only around 22% of the IT profession. Much attention has been focused on increasing the number of women studying computer science and engineering programs and their participation in the industry (Applewhite, 2002; Cohoon, 2001). Programs aim at increasing awareness of IT careers, promoting female role models, increasing young girls' participation in math and science, exploring female-friendly pedagogy, offering alternative entry routes, as well as providing mentors and networking opportunities. However the evidence of the long term impacts is uneven (Cukier & Chauncey, 2004).

Scholars (Ramsey & McCorduck, 2005) have begun to probe beyond the barriers to explore issues related to professional identity in the face of systemic stereotyping, dualism, and devaluation. Studies have shown many women articulated an interest in "computing with a purpose" as opposed to "hacking for hacking's sake". There are also issues of perceptions; both male and female respondents lack information about the nature of the work and overwhelmingly perceived it as a masculinized domain; the females mainly saw IT courses as boring and difficult. Females tend to be more interested in the application of technology than "the technical bits" (Grundy, 1996). Computer science programs that place more emphasis on the application of technology in context and a strong emphasis on teamwork, communication, personal growth, and commitment, such as Purdue's EPIC program, attract a substantially higher percentage of women than traditional computer science programs (Jamieson, 2001).

Research shows the tendency to gender type tasks as male or female (Krefting, Berger, & Wallace, 1978), and there is ample research to show that technology work tends to be framed as mens-work (Perry & Greber, 1990). The masculine gender role may become associated with male-dominant contexts and associated behaviors, and values become institutionalized. The literature also suggests that the proportion of women in a particular context is negatively related to rewards and that men tend to occupy higher status and higher paying jobs and occupations than women do (Konrad, 2004).

The nature of the profession is changing. Denning (2000) has suggested that there are over 40 organized professional groups in computing and information technologies and that interdisciplinary studies are growing. He proposes a redefinition of the profession to include what he terms "IT specific disciplines, IT intensive disciplines, and IT supportive occupations".

This article will explore the intersection of these two notions: (1) that women are more likely to be interested in the application of technology to solve problems than in the "technical" bits and (2) that the IT profession is broader than computer science and engineering. It will also consider (3) the ways in which the institutionalization of the profession itself affects the participation of women.

Industry data show that the shape of the information technology profession in Canada has changed and that the skills it demands are multi-disciplinary. Non-technical and soft skills based positions will be increasingly important. Technical competence will not be sufficient (SHRC, 2003). A survey by the Software Human Resources Council of Canada identifies 27 different segments in the IT workplace (Gunderson, Jacobs, & Vaillancourt, 2005).

MAIN BODY: GENDER IMPLICATIONS OF DEFINING THE IT PROFESSION

- **Proposition 1: The under-representation of women in engineering and computer science disciplines is not an appropriate metric for assessing women's participation in the information systems profession.** Women's absence in computing is not a general phenomenon, but rather women are under-represented in particular forms of computing such as software engineering (Clegg & Trayhurn, 2000; Grundy, 1996). Women account for 15% of electrical engineering, 21% of applied computer science, 49% of business administration, 62% of mass communications, and 73% of library science programs. Where the focus is the application and management of information technology, female participation is close to 33%. These patterns also hold for the gender distribution of faculty. Similar findings have been reported for the United States (Cukier, Devine, & Shortt, 2002).

Studies from industry reinforce the gender imbalance in subsets of IT occupations.

A study from the Canadian Software Human Resources Council (SHRC), based on a National Survey of IT Occupations, used a broader definition of IT occupations, but the patterns were similar.

Table 1. The evolution of the IT profession

IT-Specific Disciplines	IT-Intensive Disciplines	IT-Supportive Occupations
Artificial intelligence	Aerospace engineering	Computer technition
Computer science	Bioinformatics	Help desk technician
Computer engineering	Cognitive science	Professional IT trainer
Computational science	Digital library science	Security specialist
Database engineering	E-commerce	System administrator
Computer graphics	Financial services	Web services designer
Human-computer interaction	Genetic engineering	Web identity designer
Network engineering	Information science	Database administrator
Operating systems	Information systems	
Performance engineering	Public policy and privacy	
Robotics	Instructional design	
Scientific computing	Knowledge engineering	
Software architecture	Management information systems	
Software engineering	Multimedia design	
System security	Telecommunications	
	Transportation	

Table 2: Proportion of female IT occupations (Gunderson et al., 2005)

	Percentage Fema
Writers	74.3
Graphic designers and illustrators	60.8
Analysts	36.8
Support	29.9
Data	25.7
Project Managers	24.9
Multimedia Developers	21.3
Trainers	21.2
Managers	19.0
Programmers	16.7
Operators	15.5
Technicians	14.8
Software engineers	13.0
Other engineers	9.0

Source: Gunderson et al., 2005

Writers and graphic designers are predominantly female. More than one third of analysts are female. On the other hand, only 16% of computer programmers and an even lower proportion of engineers are female.

Another study used different definitions and a different methodology but still showed that more than twice as many women were analysts compared to engineers in the IT sector (Wolfson, 2003). There is substantial variation among segments in terms of the representation of women.

Similar patterns are found in research institutions and successful research grant recipients; interdisciplinary research into technology, such as the TeleLearning Network Centres of Excellence, tend to have more gender balance (50% female) than centers focused on "the technical bits" such as the Canadian Institute for Telecommunications Research (CITR) with 6% (Cukier, 2002).

Finally, while further study is needed, many women who define themselves as "IT professionals" have not entered the profession via computer science or engineering. A recent survey of members of the "Wired Woman" association revealed that while the majority define themselves as IT professionals (64%), only a fraction (11%) are computer scientists and none are engineers (cited in Cukier et al., 2002).

- **Proposition 2: Qualifications for Information Technology which are not related to performance may become "taken for granted" and institutionalized.** The institutionalization of professions and the role of "actors", including the state, legal entities, and professional associations, have been studied in a variety of contexts (MacDonald, 1995; Meyer, 1994). Less attention has been paid to the *process* of institutionalizing the IT profession. It has been shown that organizations are rewarded for conforming to the requirements, such as corporate training programs, irrespective of whether they support improved performance (Scott & Meyer, 1994). Qualifications may become institutionalized and present unintended barriers to certain segments of the population. These become forms of systemic discrimination (Ontario Human Rights Commission, 1999).

Discursive practices are the taken-for-granted, systematic, and consistent ways of speaking about phenomenon that shape the perception of the phenomenon. Language both reflects and shapes a culture and so has implications for women in the professions (Atkinson & Delamon, 1990).

Discourses of associations, employers, IT professionals, and academics reinforce the notion that an "IT professional" is synonymous with computer scientist (Cukier, 2003). This is at odds with the empirical evidence, described previously, which shows the demand in the industry is for a broader range of skills. John Roth, former president of Nortel and an engineer, emphasized the shortage of engineers, mathematicians, and computer scientists (Roth, 1997). In contrast, Carol Stephenson, former president of Lucent Canada and a psychology graduate, stressed the importance of disciplinary diversity in the IT workforce because "the soft skills are hard" (cited in Brody, Cukier, Grant, Holland, Middleton, & Shortt, 2003). In spite of the emphasis on technical skills, she maintained that interpersonal and communications skills were even more valuable and less commonplace.

Hi-tech companies, dominated by computer scientists and engineers, perpetrate the practice of hiring in their own image. Despite clear evidence that graduates of many technology-related disciplines have the necessary skills and do succeed in the sector, there is clear bias toward hiring from traditional (and also male dominated) disciplines (Cukier, 2003).

The Canadian Association of Advanced Technology (CATA) and the Information Technology Association of Canada (ITAC) pushed the government to invest in "doubling the pipeline" and creating more spaces for computer science and engineering students. There was no consideration of other disciplines or attention to the gender dimensions (Ontario Ministry of Education and Training, 1998). Three years later they announced there was actually not a shortage of computer scientists but a need for soft skills (ITAC & IDC, 2002).

Even companies which profess commitment to promoting women in IT reinforce this discourse. At a recent conference, IBM's vice president of Industry Solutions argued that changes in the industry make it necessary to recruit from a broader range of disciplines, yet the presentation on Women in IT referred only to engineering and computer science programs (IBM, 2004), reinforcing definitions and stereotypes which tend to exclude women.

Requirements which do not link to performance may also have unintended consequences. Grundy (1996) argues that proficiency at mathematics does not necessarily help with non-mathematical abstractions in computing and, conversely, students could be proficient in the areas of non-mathematical abstraction in computing without necessarily being good at mathematics. Yet, the focus remains : "Teach girls how to program. To write a program, like solving a math problem, is to discover a pattern with logic. If girls can do mathematics, and they manifestly can, they can program" (De Palma, 2001). At issue here is not an essentialist question, that is, whether or not men are inherently more mathematical than women. Rather relying on mathematics as a barrier to entry and core skill in IT educational programs may exclude women. Data from the University of Limerick (1998) reinforces the point that not all information technology disciplines rely on math. All students in math and computing had advanced math, as did 80% of students in computer systems compared to only 25% of students in applied computing or 10% of those in business and computing did. Mathematics may serve a symbolic or political function (Hacker, 1990; Schiebinger, 1999). Certainly the emphasis on mathematics is consistent with other tendencies to value skills constructed as "male" and devalue skills constructed as female. Discourses of technology contribute to sustaining gender disparities in technology-related fields (Hanson, 1997). While technology includes a wide range of practices, the tendency to narrow the definition to "the technical bits" has the effect of excluding women (De Palma, 2001).

- **Proposition 3: These institutions are (a) dominated by men, computer scientists, and engineers; and (b) in spite of the evidence to the contrary, they tend to reinforce the definition of Information Systems Professional as computer scientist or engineer and (c) tend to emphasize skills such as mathematics thought to be associated with these disciplines.** Women are under-represented at senior management levels in the IT industry. They are also under-represented in the professional associations and educational institutions. In 2001, for example, the Canadian Advanced Technology Association's board was 96% male (CATA, 2001) and the Information Technology Association of Canada's Board of Directors was 87% male (ITAC, 2002). More research is needed to explore this, but the women who are prominent tend to be computer scientists and engineers.

Even programs sponsored by industry with the stated intention of encouraging more women to enter IT tend to focus on computer science and engineering. A review of 70 existing Canadian programs aimed at increasing women's participation in IT (Cukier & Chauncey, 2004) reveals that most are based on a relatively narrow definition of "information technology professional". Academics in computer science, even those actively engaged in promoting women in the profession, are often also inclined to reproduce their own image, and consistently define the IT Profession as Computer Scientists and Engineers (Klawe, Cavers, Popowich, & Chen, 2000).

Proposition 4: The current institutional environment, which includes government programs, industry and professional associations, employment practices, granting councils, and educational institutions, tends to (a) exclude and marginalize women entering the profession from other disciplines; (b) reinforce negative stereotypes of the IS profession which are known to discourage women from entering the profession; and (c) devalue skills associated with females (the soft skills).

Engineering and computer science programs have lower representation of women than disciplines such as information systems management or library science. Some segments within the IT profession (multimedia designers and analysts) have higher female representation than others. Consequently, a narrow definition of IT professional tends to privilege male dominated disciplines and marginalize those that are female dominated.

Another unintended consequence of this is to reinforce the negative stereotypes of IT professionals by over-emphasizing the "technical bits". Considerable research has shown that this is a disincentive to female participation.

While studies of employer needs have stressed the critical importance of soft skills in the IT profession, these skills, which are often associated with females, are devalued as qualifications. As Grint and Gill (1995) note, the concept of "skill" is subjective. This suggests the tendency to valorize hard skills (which are masculinized) over soft skills (which are feminized) in the IT profession.

FUTURE DIRECTIONS

This article suggests many avenues for further research regarding discursive practices and definition of IT in industry, professional associations, universities, government programs, and media. A systematic assessment is needed of industry recruitment, hiring practices, promotion, work environment, evaluation, and mentoring systems which defines skills and qualifications for IT workers and also influences government policy, industry associations, and educational institutions.

Increasing participation of women depends on valuing diversity in approaches to information technology and "respecting multiple points of entry" (AAUW, 2000).

Progress is slow and even women in engineering and computer science resist broadening the definition of IT. One reviewer wrote,

I have a degree in engineering, a PhD in business and taught both Management of Information Systems and Systems Analysis for years. I am also a woman. I found many of the ideas expressed ... to be naïve, unfounded, biased and non-theoretical. I also found their arguments on why IT should not be restricted to computer science and engineering but expanded to include things [like] library science, information systems management and digital media design to be naïve and unfounded. ... Deciding to call the sky green does not make it less blue. (SSHRC, 2003)

CONCLUSION

Practices associated with the institutionalization of the IT profession may present barriers to the participation of women. The narrow definition of IT Professional seems at odds with the increasingly multidisciplinary nature of the industry and the demand for a workforce with a broad range of skills sets.

The notion that computer science, engineering, and mathematics proficiency are the only entry routes to the IT profession may, in the same way, have unintended consequences for women. In addition, the (mis)representation of the IT Profession in this way reinforces the stereotypes of it as a technocentric profession rather than one with broader appeal, requiring diverse disciplines and skill sets. More study is needed to explore the ways in which our definition of IT professional, the occupational categories, skill requirements, education, and admission requirements may present unintended barriers.

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KEY TERMS

Discourse: The aggregate of written and spoken textualizations. "Institutionalized language codes for articulation of the social construction of reality and events" or taken for granted ways of speaking which shape ways of understanding.

Discursive Practices: The "taken-for-granted", systematic, and consistent ways of speaking or behaving that characterize phenomena in particular ways, and that limit descriptions of them in other ways; shaping the perception of the phenomenon is shaped by the discourse.

Hard Skills: Skills that are generally borne out of discipline, knowledge, and training. For example, the ability to write a computer program and engineering the architecture of an information system are hard skills. These are often the result of skill or object specific training.

Institutionalization: "A product of the political efforts of actors to accomplish their ends; and the success of an institutionalization project and the form the resulting institution takes depends on the relative power of the actors who support, oppose, or otherwise strive to influence it" (DiMaggio in Alvarez, 1996, p. 94).

Soft Skills: Skills that are generally the result of talent, intuition, socialization, and practice. Soft skills include people-oriented tasks such as communication skills, sales, coaching, and counseling.

Systemic Discrimination: Found in existing structures, policies and/or practices in the school or workplace impose barriers, both subtle and unsubtle, to some individuals, based on a prohibited ground (race, gender, etc.). This may include the existence of a qualification not required for the position, which has the unintended consequence of excluding groups based on a prohibited ground.

Technocentric: Refers to a focus on the technological features and qualities of an idea, concept, or practice. The term implies that features or qualities that are not of a technical nature are marginalized or disregarded.

Virtual Learning and Teaching Environments

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INTRODUCTION

Without a well-thought-out didactic concept, the best surface design isn't of any help.

This article contains results from an empirical study I conducted independently. It was developed in the context of the umbrella project "gender and information technologies" in the context of the Vifu (virtual international women university), a project financed by Germany's Federal Ministry of Education and Research (BMBF) and carried out at the Center for Interdisciplinary Research on Women at the University of Kiel. This empirical study provides insight into the field of "virtual learning and teaching". It is based on an expert survey and reflects the specific experience instructors had with virtual seminars. The study focuses on the following question:

What convergences and divergences can be identified in experts' specific experience with forms of virtual teaching?

I proceeded from the assumption that intercultural and gender factors affect the design, structure, and implementation of virtual learning and teaching environments. This assumption shaped the study.

Experts were generally defined as all persons who have practical experience in virtual teaching, especially in the research fields of gender and computer sciences. Since virtual learning and teaching environments is a new, experimental field, none of the interviewed experts had more than two to three years of teaching experience in this area. Some of them have programmed and developed the online module themselves.

Most of the fourteen interviews were conducted face-to-face, three of the interview partners were sent a questionnaire by e-mail. With them I conducted "semi-standardized interviews" (Mayring, 1996) and all were evaluated with the core sentence method. Core sentences are "natural generalizations" used by the interview partners themselves (Leithäuser & Volmerg, 1988; Volmerg, Senghaas-Knobloch, & Leithäuser, 1986). These are statements that make a point succinctly, reducing entire paragraphs to a single statement. In contrast to the deductive method, the inductive method I used has the advantage that the meaning of the "spoken word" is not lost. It is particularly useful in the development of hypotheses.

FINDINGS

Virtual Learning and Teaching Environment as Science in Action

It has always been that way here. Each project must have two people pushing it ...

Virtual teaching and learning are still fields of experimentation. It is surely not incorrect to claim that all noted interview partners have done pioneer work emphasizing the area of "virtual teaching." One citation taken of an interviewee can thus be considered representative for the situation found in virtual teaching:

... we were well among the first who at all had a virtual college. There was a college [XXX],[1] *a virtual college, two years ago, already three years ago, when the net had just gotten started. So we immediately had a huge project since someone was interested in it here. It has always been that way here. Each project must have two people pushing it, carrying the project, and the other fellow workers then more or less work through the daily loads ...*

Against this background, the network of scientists involved in virtual teaching is to be classified as 'weak,' even if several experts directly cooperate with each other.

The term *science in action,* coined by Bruno Latour (1987), should thus convey the essence of what the surveyed community expressed. In the end, it is all about "science having not become cold" yet. A research and work area which is still in its preliminary stages has been described as a science in action by Latour. The actors and their related technical apparatus are thus to a large extent still in the so-called hot phases, the "science in the making" or "science in action" stage. The capacities are (still) above all oriented inwards. It is not until the stabilization phases (translating interests) that the activities are outwardly intensified (Latour, 1987). These "translations" consist of translations of one's own interpretations into others' taking place in the course of the establishing of scientific and technical constructions. In a successful interpretation, one's own interests are translated into those of others, in whose interest it is also to support one's own interpretations, approach, or technical innovation. Latour's concept of "translating interests" is not only limited to the phase of stabilization. Since this translation process, however, only unfolds its full impact in the phase of stabilization, the localizing from my point of view seems legitimate. With reference to the virtual teaching environment, the actors can not be analytically separated from their financial, technical, and societal structuring potential. They must rather be situated in their interlaced structural diversity—which Latour would describe as hybridity.

It is to be expected that with the expansion of the field of virtual learning intensified—internationally oriented—networking and differentiation will take place. The interviewees' responses thus provide a similarly detailed, as well as lively, snapshot at a certain point in time of the research field of virtual learning.

Technology development can therefore be seen as a social activity which is influenced by existing social structure, gendered values, and cultural practices. Virtual learning proposals should be given attention to make them more user oriented. Gender mainstreaming and diversity strategies in this context have a big impact, because technology is not a fixed product, but an configurable open process (Schelhowe, 2001; Zorn, 2004).

Gender and Culture as Moments of Selection

... computers are much more gendered in the domestic environment than they are in the work environment ...

Internet competency should be mentioned as an important aspect in the context of virtual learning environments (Kreutzner & Schelhowe, 2002). For example, one expert was amazed that some participants "couldn't even manage to enroll in a virtual seminar on the internet." This procedure may be considered standard practice by Western academics, but it poses a problem to individuals from other social backgrounds and cultures. In order to avoid misconceptions, we must emphasize here that an individual's inability to carry out what appears to be a "simple procedure," such as enrolling for a course, can by no means be attributed one-dimensionally to social causes, (e.g., that the person is considered) (in a "deficit-oriented approach") to belong to a group characterized by "deficient internet competency." Quite often, the reason simply is a participant's insufficient computer resources or other infrastructural impediments. Thus it is not at all clear what instructors can be expecting from students as basic "internet competency" or as a "technological standard."

An important aspect of gender has often been overlooked: the existence of a computer in the household by no means guarantees access for women! The following quote sheds light on how closely technical infrastructure conditions for example are related to the category of gender:

... computers are much more gendered in the domestic environment than they are in the work environment, and this is based on empirical evidence from our students, men and women, about what they can do and the access that they have over computers. So, for example, men and women who have access to computers in the work place in general have a very similar kind of access. Women are a little bit more restricted, but not terribly. The restrictions tend to be the same,

they tend to have the same amount of access, but men and women who have access to a computer that belongs to the family or home, have totally different kinds of access, which reflects real gendering in the household ... And governments and funders don't want to hear that ... It sounds too big to address, so instead, they much prefer some kind of solution which is something they can do outside of the family"

Technology, as the quote shows, is by no means an independent entity. Unless the role of gender constructions in societal discourse is rendered transparent, the interconnections between technology and society cannot easily be traced. Gender and the cultural and social background are interrelated and together can have a strong, multiple effect on participation and drop-out rates (Green & Adam, 2001; Wiesner, 2003). For this reason, technological infrastructure and internet competency cannot be treated as independent entities, but must instead be analyzed as contextually embedded and interconnected. In brief, the categories *gender* and *culture* play a considerable role in the context of virtual learning environments.

Communication in Action

The largest problem ... with virtual courses is the people who don't say anything!

Even when conducted synchronously, online discussions occur in a temporally slightly delayed fashion. The impression that the contributions argumentatively build on one another can thus be misleading. Further, some virtual seminars come about without video support and hence without facial expressions and gestures. *Pure listeners* can therefore not be observed. They run the danger of being declared inactive students while they consider themselves to be active course participants.

Chatting in this sense also is something that must be learned! It indeed appears to constitute a new—hybrid—form of communication, one of intermediate quality:

Well, it's not as good, but it is better than nothing ... this is somewhere in-between.

Though assuming very different forms, these hybrid phenomena will gain importance in the future. Haraway—much like Latour (1998)—insists on the unaccustomed, (i.e., "the non-anthropomorphic and non-substantial quality of unexpected action competencies") (Haraway, 1995). In this context, the technological challenge for example consists in integrating technology in a "more malleable fashion" into interactive interpersonal processes.

While most of the experts cited in an exemplary fashion either gender-specific or culturally related different styles of communication, one expert did not make such a clear distinction, but rather gave a response pointing out interrelationships:

... if there is a gap concerning being self-confident ... then this might be related to gender, to cultural differences, but also to the level of education. One can under certain circumstances also apply to the M.A. programme without any first university degree, namely on the basis of many years of work experience. For example, in one of my courses, I had a mid-level manager from a steel company, who started as a craftsman, worked his way up and now wanted to acquire the academic degree in order to have more job security. These people have a lot to contribute in such a learning group ... but at first they are mostly for some time reserved and naturally in the area of academics also less capable of articulating themselves well. What of course does not mean that they know less ... Under certain circumstances this plays a greater role than gender.

Even if this description should not be limited to computer-facilitated communication but can also be true for face-to-face methods, it is evident that the internet in no way provides for an unlimitedly unbiased communication (Herring, 2003). In computer-facilitated communication, the use of *language* is of very special importance and the scope of its potential becomes even greater in the frame of intercultural exchange. In the process of mutual perception and evaluation, the intercultural dimension of active conceptualization and codes is of particular importance. Beside the primary socialized cultural background, these are co-determined by every individual life-world and world perspective. Indeed, before taking off on "cultural differences" much too rashly, one should definitely be wary at this point. The cultural differences can be attributed to an often underestimated aspect: the agreement on one "common language."

Determining one language generally leads to the exclusion of others and thus of other groups within the population. Communication in a language other than one's own requires more consideration of the interaction partners and thus demands more time, in particular in connection with communication in writing. The required transformation of expert terminology in the operative language can moreover make communication more difficult. The most interviewed experts did underestimate this aspect in their own point of view.

Didactic Preparation Important

Without a well-thought-out didactic concept, the best surface design isn't of any help.

As far as the conceptual development of the virtual courses is concerned, the experts' virtual teaching style can roughly be divided into three groups: "highly prestructured," "groupwork-oriented" and "flexible."

In this context, the first group is assigned the term "highly prestructured." Their courses are provided with a considerable amount of instructions, e.g. supervision of each step in the lesson, linear text guidelines, and the keeping up with assignments within the given time frame. According to a respondent, this course structure is particularly appropriate for acquiring factual knowledge.

With the second, "group work-oriented," group of experts, the courses were developed closely with the participants. They often work with different concepts by directly reacting to the participants' manner of working and critiques. The terms most frequently used during the interviews in this context were "group-oriented," "network oriented," and "community-building." It should be emphasized that the teaching staff made the social constructive dimension of teaching (and learning) very important in their courses.

The third group is assigned a position half-way between the above-mentioned positions. One person calls the structure of the course a mix-form, a "hybrid structure." Due to the quite factually-oriented and action-oriented approach, the group chose to describe it as "pre-structured as well as network-oriented." The structured course instructions were made "a little more flexible" from the very beginning, with lesson units that included learning through discovering and group-work activities.

Most instructors in the study initially were of the opinion that it would suffice to use conventional seminars and "simply put them on the net." Yet, according to many experts, precisely the conventional course type has proven generally unsuccessful on the net. Just one example:

You have to be a little bit postmodern and you have to take some risks, and accept that what you offer may not be what people want.

Most interview partners thus lamented that they had not taken enough time to reflect on didactic methods. Precisely this was considered by all experts to be a grave deficit in the design and implementation of virtual lesson plans.

The formation of an academic community, (i.e., interpersonal networking), has had a strikingly positive effect on participation and drop-out rates, above all among women (Wiesner et al. 2004; Zorn, 2004). Seminars in which the participants could work networked or in groups discursively had substantially lower drop-out rates (especially of women) than those in which the participants only had direct contact to the instructor and worked on their own. In this regard, two important aspects can be identified in the answer patterns of the interviewed experts. First, a continual *interest-building process* has a positive effect on the participants of the virtual seminars offered by the experts. Second, the networking process of community-building is supported by the opportunity for participants to meet one another outside of official (online) sessions *in an informal setting*, (e.g., via chat rooms, mailing lists or even informal live encounters). But all communication-tools should be embedded in a (moderated) collaborative learning context, otherwise the communication between the participants of a learning module won't work and the learning outcome is low (Baumgartner, 2005; Luck, 2004).

Long-Term Prospects of Virtual Educational Forms

It depends on the target group ..., if you take the normal students at universities ... they actually don't voluntarily take any virtual courses.

It is not only a purposeful pragmatic optimism that misleads the experts to make statements like: "... I think of the seventeen courses, I am sure some of them, probably half, will come up with some good results." Much more, this quote reflects the state of research on virtual learning: "The philosophers' stone has not yet been found." Experimental enthusiasm is just not rewarded from the start. Success and failure are standing close to one another in this first phase.

... what I would like to do, is just to offer a lot of courses, a variety of courses, and just try to test how it works ... We are trying to discover who will be interested, how many people and how we can make our courses more attractive. So what can I say, we are in a very interesting phase—which is an experiment ...

The question now arising of course is: where should we go from here? There is no reason to believe, contrary to recurrent journalistic pronouncements (Gaschke, 2000; Schönert, 2000), that in the near future university education will only take place in virtual classrooms. The core sentence, "[a] virtual seminar as a supplementary offering is certainly worthwhile, but not as a substitute," summarizes the opinions expressed by the experts as a whole.

Individuals who explicitly opt for virtual seminars—and above all those who remain in them—are far more similar to students in "education at a distance" than to "normal students" in conventional presence universities. I would like to again cite a statement I quoted earlier:

It depends on the target group ... When you take the normal students at universities, ... they actually don't voluntarily take any virtual courses.

This statement is in fact confirmed by all interview partners!

The experts were nearly unanimously of the opinion that individuals who participate in virtual seminars must be highly self-organized: "these are people who are actually 80% sure that they will study on their own at home." At the same time, as another interview partner noted, people who take part in such courses are such "for whom the alternative 'I will learn through reading alone' does not suffice ... There are a great number of people who are capable of learning from books. They have no need for virtual courses."

One can thus begin to speak of a new–hitherto unnoticed—or "*other type of student*," who can be located midway between the students of a traditional distance university and those of a conventional presence university. This assumption is supported by the efforts of experts to develop more open universities: the providers of virtual seminars appear to no longer orient themselves at traditional educational models. Most experts offer their courses not only in initial training or education, but also simultaneously in advanced and continuing education. They construct the division between initial and continuing education opportunities more permeably and thus make it appear obsolete (Wiesner, 2003, pp. 35-37).

Participants in virtual seminars thus constitute a largely unnoticed type of student. The conclusions we can draw from this are ambivalent. Virtual seminars can be organized relatively independent of time and space. Studies show that this aspect could be a real chance for women (Luck, 2004; Zorn, 2004). This may be also well-suited to some male and female students' needs, for an increasingly large group of students declare their studies to no longer be "the focal point of their life". In addition, occupational demands are rising incessantly. Working adults without "additional qualifications" expect to face "harder times" over the medium-term. Life-long learning bears opportunities *and* risks. Virtual teaching and learning environments are extremely "compatible", in that they (seemingly) match the interests of today's "student community" with those of the economy and of demands related to the organization of work particular to each society. Only against this complex and highly ambivalent background can the emergence of virtual courses be explained and meaningfully integrated into the existing educational landscape.

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KEY TERMS

Core Sentences: Natural generalizations used by interview partners to reduce entire interview response paragraphs to a single statement.

Internet Competency: The adequate ability and knowledge of the Internet.

Science in Action: Coined by Bruno Latour (1987); conveys the essence of what the surveyed community expresses at the preliminary stages of research.

Virtual Learning Environment: An information system used to facilitate student learning via online educational courses.

Virtual Teaching Environment: An information system used to facilitate teaching of online educational courses.

ENDNOTE

1 [XXX] indicates anonymity.

V

Vulnerability to Internet Crime and Gender Issues

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INTRODUCTION

A tremendous growth in the use of the Internet has been observed in the past two decades. More than 75% of Americans participate in online activities (University of Southern California Annenberg School Center for the Digital Future, 2004) such as e-mail, Web browsing, working from home, accessing news stories, seeking information, instant messaging, using the Internet in lieu of the library for school work, playing games, and managing personal finance. For professionals, the Internet is an important medium for networking and building social capital. However, along with all positive impacts, there are also negative outcomes. One such negative outcome includes Internet crimes. Dowland, Furnell, Illingworth, and Reynolds (1999) state that "with society's widespread use of and, in some cases, reliance upon technology, significant opportunities now exist for both mischievous and malicious abuse via IT systems" (p. 715).

Internet crimes (cyber crimes) consist of specific crimes dealing with computers and networks (such as hacking, spreading of viruses, and worms) and the facilitation of traditional crime through the use of computers on the Internet (such as child pornography, hate crimes, telemarketing/Internet fraud). This article focuses on Internet crimes, especially those affecting individual users, and offers a discussion of issues regarding Internet crimes and gender.

BACKGROUND

Cyber Crime

Computer crimes can be categorized by who commits them and what their motivation might be (e.g., professional criminals looking for financial gain, angry ex-employees looking for revenge, hackers looking for intellectual challenge), or by the types of computer security that ought to prevent them (e.g., breaches of physical security, personnel security, communications and data security, and operations security). These crimes can also be understood by how they are perpetrated (e.g., by use of the Internet or by use of physical means such as arson). For the purpose of this article, we will consider the method of perpetration, that is, crime committed via the Internet to hurt individual users, as the focus of the discussion below. Table 1 lists some common types of Internet crimes.

The 2004 Computer Crime and Security Survey, recognizes that Internet crime continues to be a significant threat. The E-Crime Watch Survey conducted by CERT Coordination center notes that nearly 70% of their survey respondents reported at least one intrusion while 43% of survey respondents reported an increase in electronic crimes. Organizations are harmed by insiders, such as employees or contractors, and outsiders (Computer Emergency Response Team Coordination Center, 2004, p. 6). CERT 1988-2004 statistics shows that incidents of

Table 1. Selected examples of Internet crimes

Malicious codes:

Logic Bomb: Destructive procedures that execute when some prescribed condition occurs (e.g., a specific date).

Trojan Horse: A secret program hidden within an inviting disguise.

Virus. A form of Trojan Horse. A piece of code that attaches itself to a files, and sometimes to a sensitive system sector of the victim computer's hard disk; malware that infects files and spreads when the file executes or is executed by another program; requires that its host program be run to activate it.

Worm. A software program that runs independently, consuming the resources of its host in order to maintain itself and propagating a complete working version of itself onto another machine on the network without intervention.

Trap Door or Back Door: an unauthorized program that bypasses security or other normal procedures.

Spoof: Programs that pretend to be another program.

Hacking. Intentionally accessing (using) a computer without authorization or beyond authorized permission.

SPAM. Unsolicited e-mail (electronic junk mail). Spam can occasionally 'flood" a host computer or network to the point that it significantly slows down the data flow.

Social engineering. Tricking an employee into giving out information or taking an action that reduces security or harms a system.

Phishing. Term coined by hackers who imitate legitimate companies in e-mails to entice people to share passwords or credit-card numbers.

Identity Theft. Masquerading (when one person uses the identity of another to gain access to a computer or other personal assets) with social engineering tactics or other means

Theft of Intellectual Property: Crimes in which someone wrongfully obtains and uses another person's personal data in some way that involves fraud or deception, typically for economic gain.

Internet Frauds: Any type of fraud scheme that uses one or more components of the Internet - such as chat rooms, e-mail, message boards, or Web sites - to present fraudulent solicitations to prospective victims, to conduct fraudulent transactions, or to transmit the proceeds of fraud to financial institutions or to other connected with the scheme.

Investment Fraud
Credit/debit Card Fraud
Non-delivery (mdse and payment)
Auction Fraud
False Advertising

Cyber stalking/On-line Harassment. The use of the Internet, e-mail, or other electronic communications device to stalk another person.

Internet Crimes Against Children*

- Enticing them through online contact for the purpose of engaging them in sexual acts.
- Using the Internet for the production, manufacture, and distribution of child pornography.
- Using the Internet to expose youth to child pornography and encourage them to exchange pornography.

* U.S. Department of Justice, Office of Justice Programs

Table 2. Increase in reported incidents and fraud complaints over time

	1990	1995	2000	2001	2002	2003	2004
Incidents reported at CERT (a)	252	2,412	21,756	52,658	82,094	137,529	-NA-
Complaints received via IFCC website (b)			16,838	49,959	75,063	124,509	190,143

Sources: (a) Computer Emergency Response Team Coordination Center--*CERT/CC Statistics 1988-2004*.
(b) Internet Fraud Complaint Center–*IC3 2004 Internet Fraud Report*

systems or data intrusions are continuously increasing. In 2003-2004, the reported incidents increased by nearly 67% (see Table 2).

Internet Crimes Targeting Individuals

The Internet Fraud Compliant Center (IFCC) report shows that traditional crimes such as fraud, identity theft, and harassment are on the rise. Furthermore, these crimes are now committed with the use of the Internet (Internet Fraud Complaint Center 2004). IFCC, which deals with Internet fraud, also receives complaints regarding child pornography (redirected to National Center for Missing and Exploited Children), computer intrusion (redirected to National Infrastructure Protection Center), SPAM e-mail, and identity theft (redirected to Federal Trade Commission). Victims of the well-known Nigerian letter fraud, which has been in existence since the early 1980s, have lost millions of dollars. The Nigerian letter fraud and other credit card frauds are handled by the U.S. Secret Service.

The financial loss incurred through the above fraudulent activities is extensive but the new emergence of crime against children and crime against women using the Internet are even more disturbing (Sones, n.d.). In the recent past, Internet crime against children, such as child pornography, has also been on the increase. Some of the common types of crime against children include enticing them through online contact for the purpose of engaging them in sexual acts, using the Internet for the distribution of child pornography, using the Internet to expose youth to child pornography, and encouraging them to exchange pornography.

Cyber-stalking or online harassment, where one individual harasses another individual on the Internet using various modes of transmission such as electronic mail, chat rooms, newsgroups, mail exploders, and the World Wide Web is also on the rise (National

White Collar Crime Center, n.d.). The Internet makes stalking much easier for the perpetrator than off-line stalking. The anonymity of e-mail and chat rooms hide stalkers well, and stalkers can easily access private information about their victims via the Internet (Violence, Women, & Media, n.d.). Online harassments can range from minor annoyance to deadly outcomes. Ackerman (1997) notes that approximately 1 million women and 370,000 men are stalked each year. In studying off-line stalking, Tjaden and Thoennes (1998) found that women are far more likely to be victims of stalking than men. Such is true also for online stalking.

The growth in crime and unlawful practices connected with Internet use is has resulted in the introduction of regulations or legislations pertaining to Internet use. In the United States, Homeland Security Act of 2003 or the USA Patriot Act has amendments to handle computer crimes. In addition, federal criminal codes have specific provisions to deal with computer intrusion (visit http://www.cybercrime.gov/cclaws.html). At the international level, the EU led International Convention on Cybercrime seeks to set international standards for the policing of electronic networks (Rowe, 2004).

VULNERABILITY TO INTERNET CRIME AND GENDER ISSUES

Gender Issues in Computer Use and Communication

The literature on women in IT has a substantial section focusing on gender differences in computer use, education, and career paths. These studies have shown relevance of gender on how an individual adopts, perceives, and uses technology. In the earlier years of the Internet, the number of male users exceeded female users and created a gender gap. Recent statistics shows a reversal of this trend. The critical difference now is based on the difference in online activities between men and women. For example, women use the Internet more for interpersonal communication, information search or education, while men use the Internet more for one-way communication, entertainment, or personal finance (Banerjee, Kang, Bagchi-Sen, & Rao, 2005).

Gender can play an important role in determining technology use as well (Whitley, Jr. 1997). Considerable research has been conducted to find out whether females are likely to hold negative attitudes toward computers than males resulting in "technological gender gap". For instance, Venkatesh and Morris (2000) found gender difference in individual adoption and sustained usage of technology in the workplace. Ellison (1999) notes that men tend to be more adversarial; they use intimidation tactics to dominate and control online discourse. Elder, Gardner, and Ruth (1987) found that females are more likely to experience physical and emotional burnout caused by inability to adapt to new technology and older workers are more likely to experience "technostress" compared to younger workers.

The gender inequity in information technology can be reasonably explained by different male-female cognitive structures, that is, individual differences in encoding, processing, and organizing information, which leads to differentiated judgments (Bem, 1981). Several studies have attempted to understand the difference in technology use by males and females. In 2001, Jackson, Ervin, Gardner, and Schmitt found that women used e-mails more than males for interpersonal communication while men used Internet for information gathering. Gefen and Straub (1997) found that men and women appear to derive different meaning from the same use of technology and that the women and men differ in their perception and use of e-mail. Specifically, they found that "women perceive networking more useful than do men, and thus have tendency to see support, intimacy and cooperative behavior through e-mail (p. 389)". In their review of sociolinguistic literature, Gefen and Straub (1997) find that, to some extent, women and men use and understand similar messages quite differently.

This article provides a launching ground for exploring whether gender will be one of the factors in understanding vulnerability to Internet crime.

Gender Issues in Vulnerability to Internet Crimes

The Internet enables people to buy, sell, and trade images and videos that portray sexual exploitation of women and enables sex tourism as well as the advertisement of mail order brides. These sex crimes are examples of crimes against women, which use this new uncontrolled media outlet to carry out the crimes that are considered as violation of human rights. Organizations such as "Working to Halt Online Abuse" are working to combat as well get attention of law authorities to this issue.

The attitudinal, emotional, educational, perceptional, and cognitive differences that were discussed in the previous subsection may affect the vulnerability of a user based on gender. For example, perceptional and cognitive differences may put girls and women at more risk to social engineering tactics. As more women go online, the probability of exposure to Internet frauds will be on the rise. Women's need for socialization has been established in several studies confirming that females participate more in e-mail and online communication (Jackson et al., 2001; Banerjee et al., 2005). This may expose women and girls to several other types of Internet crimes. In recent past "phishing scams" are noted to be on rise in which the social-engineering schemes use "spoofed" e-mails to lead consumers to counterfeit websites designed to trick recipients into divulging financial data such as credit card numbers, account usernames, passwords, and social security numbers (http://www.antiphishing.org/phishing_archive.html). Although not much statistics is available on victimization of women to such scams, several news reports document the incidences. For example, the current case in Kansas, USA, (December, 2004) of murder of a pregnant woman and kidnapping of her baby from the womb by a woman who met online to purchase a puppy, sheds gruesome insight into crimes committed against women that are facilitated by the Internet (http://www.nydailynews.com/front/story/263217p-225301c.html).

In their structural-choice model of victimization theory, Meier and Miethe (1993) integrate the current predominant theories of victimization, namely lifestyle-exposure theory and routine-activity theory. They discuss that exposure and target attractiveness as necessary conditions for victimization. Lifestyle characteristics such age, gender, and education as well as routine activities which may predispose individuals to riskier situations may contribute to exposure or target attractiveness of victims.

Gender differences observed and studied in a wide range of samples often disappear in certain select subgroups. For example, Parsuraman and Igbaria (1990) found no male-female differences on attitudes towards computers among highly educated participants holding managerial positions in organizations that are highly dependent on computer technology (e.g., accounting, finance, information systems, and marketing firms). Advanced education and computer training does make users more comfortable with tasks needed to secure the computer and preserve user-privacy. We can argue that relatively younger women who have had education in this era of computing will have more exposure to computer training and hence they will be less vulnerable to these crimes. However, girls with limited exposure to computer training may be more susceptible to specific types of Internet crimes. Therefore, we can postulate that educational level as well as age may influence the level of an individual's vulnerability to Internet crimes which needs to be tested.

CONCLUSION

As more users go online, we need to understand the relative importance of socio-demographic factors that affect an individual's vulnerability to Internet-based crimes. Does gender play a role? If so, within what context is the male-female difference in vulnerability to Internet crime accentuated? Recent trends show that traditional crimes such as harassment, fraud, and identity theft are now committed with the use of the Internet. Privacy and security breach of personal information carried out by virtual criminals pose a significant threat to individuals and to the society. Prior research acknowledges gender differences in the use of information technology. We need to understand if all users benefit or suffer in the same way. If not, who are the victims and how can the victimization be controlled? Most surveys noted in this study focus on computer crimes against organizations. These surveys do not give sufficient insight into crimes affecting individual users. We need to understand what makes an individual vulnerable in order to better prepare task forces and the society as a whole to combat Internet crimes. This article raises questions regarding the role of gender, age, education, and the societal context of the Internet user in predicting vulnerability to Internet crimes. Such understanding will be useful in educating individuals and households about cyber security and will be essential for law enforcement agencies to intervene before a crime is committed.

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KEY TERMS

Exploit: Noun: Attacker tool (usually a program) for exploiting a known weakness. Verb: To take advantage of a known vulnerability to attack a system.

Internet Crime (Cyber Crime): Internet crime consists of specific crimes dealing with computers and networks (such as hacking) and the facilitation of traditional crime through the use of computers (child pornography, hate crimes, telemarketing/ Internet fraud). In addition to cyber crime, it may cover the use of computers by criminals for communication and document or data storage

Privacy: The protection of individual rights to nondisclosure of information. According to the Calcutt Committee in the United Kingdom, privacy is the right of the individual to be protected against intrusion into his personal life or affairs, or those of his family, by direct physical means or by publication of information. Privacy can then be divided in several related concepts including:

1. **Information privacy,** which involves the establishment of rules governing the collection and handling of personal data such as credit information, and medical and government records. It is also known as "data protection".
2. **Privacy of communications,** which covers the security and privacy of mail, telephones, e-mail and other forms of communications. (http://www.privacyinternational.org)

Security: Policies, procedures, and technical measures used to prevent unauthorized access, alteration, theft, or physical damage to data or computer systems.

Spyware: A software that gathers user information through the user's Internet connection without his or her knowledge, usually for advertising purposes. Once installed, the spyware monitors user activities while on the Internet such as capture your keystrokes while typing the passwords, read and track your e-mail, record what sites you visit, record the credit card numbers; and transmits that information in the background to someone else.

System Vulnerability (Vulnerability): Weakness in an information system, system security procedures, internal controls, or implementation that could be exploited.

Vulnerability to Internet Crimes: Weaknesses that may subject an Internet user to become victim to an Internet Crime (e.g., lack of awareness of current threats and system vulnerabilities), inability or delay in dealing with the system vulnerabilities.

Web-Based Learning and Its Impacts on Junior Science Classes

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INTRODUCTION

The past decade has seen significant improvements in the design and development of information and communication technologies (ICT). The Internet, for instance, has become more efficient, more affordable and more accessible. While the availability of these technologies in classrooms has created new opportunities, it has at the same time presented new challenges for teachers. Teachers have to find innovative methods of implementing these technologies in lessons that are not only effective and efficient but also fair to both sexes.

BACKGROUND

ICT in Education

Technological advances in the past decade have created teaching and learning opportunities of significant proportions that would have been a fantasy a few years ago (Dierker, 1995). Gomory (2001) pointed out that while in the past many were deprived of education due to reasons such as accessibility, affordability, and personal commitments, today technology has addressed some of these issues. Learning can now be blended in with lifestyles and integrated into the daily routines of learners.

Another significant factor is that young people of today are constantly interacting with multimedia, and the new technologies "speak their language." According to Eklund, Kay, and Lynch (2003), many students in Australian schools were more skilled in using computers than their teachers. Stager (2004, para. 12) argued that by correctly harnessing these skills in technology, teachers can "breathe life into the least effective teaching practices of yore." But is a technology-driven environment a fair learning medium for both sexes?

Gender Issues

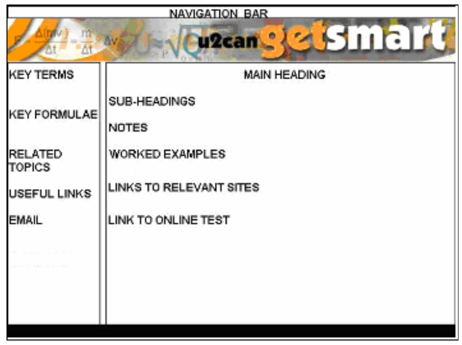
Gender issues relating to science subject selections have been an issue for some time. In recent times, the widening gap between the academic performance of boys and girls has emerged as a significant issue for educators across all subjects. According to Biddulph (1997), these days, girls are much more confident, hardworking and motivated than boys. A recent Queensland Government report pointed out that girls were more likely to complete high school than boys (Wenham & Odgers, 2004). Matters, Pitman, and Gray (1997, p. 6) believed that the "original question of whether girls have equal educational opportunities has now been replaced with that of whether boys have equal educational opportunities."

Head (as cited in Cortis & Newmarch, 2000) suggested that the performance of boys was most probably due to their preference for different learning styles. Lerner and Galambos (1996) listed a range of factors, such as motivation, curriculum, student teacher and peer interactions, as some of the possible reasons for the disparity in the performance of the two sexes. Can computers and related technologies provide a level playing field for both sexes? How can the impact of such initiatives on students be studied?

Learning Environments

In the field of learning environments, the impact of such innovations on students can be effectively measured. For more than 30 years, proven qualitative and quantitative research methods associated with learning environments have yielded productive results for educators. In this study, the perceptions of Web-based learning in a blended environment were measured using a modified version of the *Web-Learning Environment Instrument* (WEBLEI) (Chang & Fisher, 1998). The WEBLEI measures students' perceptions across four scales—Access, Interaction, Response, and Results. Theoretically, if students perceived their learning environments favorably, then this was more likely to be transformed into favorable learning outcomes.

Figure 2. Key features of the lesson page

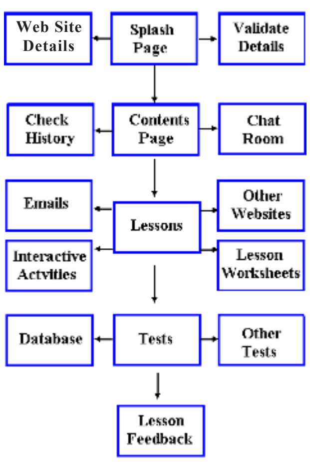


THE RESEARCH PROJECT

Design, Development, and Implementation of *Getsmart*

The layout of the *Getsmart* Web site enabled students to engage in learning activities that included opportunities for modeling, coaching, articulation, scaffolding, reflection, exploration, questioning, performance feedback, and direction instruction. These paralleled the instructional methods of "electronic cognitive apprenticeship" (Bonk & Kim, 1998; Collins, Brown, & Newman, 1989; Wang & Bonk, 2001). These learning options were created though Web-based lessons, tests, online chats and interactive activities. Figure 1 shows the general layout of the Web site.

Figure 1. The general layout of Getsmart



Students accessed the Web site through the *splash page* once their user login and password were verified. Upon a successful login, users were directed to the *contents page,* which listed all available lessons. Each *lesson page* highlighted key aspects of a topic or concept and was closely related to the work done in class. The page layout (Figure 2) was kept uniform throughout the Web site, thus ensuring that students did not have to rediscover the steps of using the Web pages each time they logged in.

Most pages were linked to either a multiple-choice or short-answers test. These tests provided instant feedback to the user. Feedback to the tests did not specify which questions were wrong, for two reasons. First, students had to understand that there was more to an answer than merely choosing an option. Second, a wrong answer was meant to encourage the student to find the correct answer. It was purposely designed in this manner to encourage interaction. The results of these tests were written in a database file that could be accessed by students and teachers.

Students were also issued with or able to download lesson worksheets. These fill-in-the-blanks worksheets served as notes for students. It also facilitated further discussion in the classroom and kept students on task.

Research Sample

This study was conducted at a state high school in Queensland, Australia. Lessons were designed for various topics in Year 10 Science and Advanced

Science. Qualitative and quantitative research data were collected from all these classes. A sample of 315 students in 11 classes participated in this study over a 2-year period.

Internet lessons were scheduled once a week and lasted for one school term at a time. During these lessons, students had the option to access the Internet for up to 35 minutes. Students also had the option of accessing the Internet on their own time.

Data Collection Methods

To obtain a fuller picture of a research initiative, a number of researchers have recommended that both qualitative and quantitative methods should be used (e.g., Jayaratne & Stewart, 1995). Consequently, in this study, data were gathered through both methods. Students' perceptions of their Web-based learning environment were established quantitatively by using a learning environment instrument. A modified version of the WEBLEI (Chang & Fisher, 1998), which was initially developed to measure student perceptions in a tertiary environment, was used in this study. Qualitative data was also gathered through written surveys. Both these surveys were administered at the end of the school term. Students were given the option to respond to the surveys on a voluntary basis.

End-of-term examination results were used to investigate the impact of this initiative on students' academic achievement. Examination results obtained by the sample were compared with their earlier results and also with groups who had completed similar assessments in previous years. In the qualitative survey, students were also asked to specifically answer questions in relation to the extent to which Web-based learning influenced their learning outcomes.

Results and Discussion

Students' Perceptions of the Learning Environment

The 32 WEBLEI items were designed in a five-point Likert response format. The responses were scored as shown in the brackets—*Strongly Agree* (5), *Agree* (4), *Neither Agree nor Disagree* (3), *Disagree* (2) and *Strongly Disagree* (1). The mean and standard deviation of boys and girls in junior science for each scale of the WEBLEI are presented in Table 1.

Table 1. Mean and standard deviations of boys and girls for the four scales of the WEBLEI

WEBLEI Scales	Descriptive Statistics: **Mean**			**Standard Deviation**		**Number of Cases**	
	Boys (1)	Girls (2)	Difference in means (1)-(2)	Boys	Girls	Boys	Girls
Access	4.04	3.92	0.12	0.65	0.55	118	90
Interaction	3.65	3.49	0.16	0.70	0.72	114	92
Response	3.86	3.72	0.14	0.68	0.68	118	91
Results	3.98	3.89	0.09	0.61	0.59	116	90

The results reported in Table 1 are interesting, because both boys and girls perceived the learning environment similarly. While the boys scored higher means for each scale, the difference between the two sexes was not statistically significant ($p<0.05$). A mean of 4.04 ($SD=0.65$) for boys and 3.92 ($SD=0.55$) for girls for the Access scale suggested that both agreed that their learning environment was easily accessible at locations suitable to them. The learning environment was also convenient and it enabled them to work at their own pace. A Web-based learning environment also gave them greater autonomy in achieving their learning objectives. Qualitative data gathered from written surveys suggested that Access characteristics of the WEBLEI were important to students:

It is easier to understand and comprehend because you can read it at your own pace and you don't have to listen to a teacher mumble on.

You can go over the work again as many times as you like. Having the Internet sheets from class lessons help you revise and study. I can go over and over the parts I don't really understand until I do. It is easy to read and understand.

The Interaction scale produced means of 3.65 ($SD=0.70$) and 3.49 ($SD=0.72$) for boys and girls, respectively—the lowest of all three scales. An average of three implied that students neither agreed nor disagreed with all the items in the scale. While the WEBLEI's Interaction scale predominantly measured students' perceptions on the use of e-mails, student responses to the written survey suggested that their interaction with the technology was more significant to them than interactions with humans via technology. Hyperlinks, links to other related Web sites, online tests, applets, pictures and graphics were the interactions highly valued.

For the Response scale, mean scores of 3.86 (*SD*=0.68) and 3.72 (*SD*=0.68) for boys and girls were obtained, respectively, which implied that both groups generally agreed that Web-based learning was satisfying and it enabled them to interact with other students and their teachers. They also enjoyed learning in this environment and believed that this approach held their interest in the subject for the whole term.

Qualitative data suggested that students also believed that Web-based learning made learning easier, interesting and, therefore, enjoyable. According to students' responses, one of the reasons why they responded positively to Web-based learning was that it took them away from the usual routine (instead of doing the same thing repeatedly). In this relaxed environment, they did not have to listen to the teacher *carry on*. Their responses also suggested that they did not have to do much writing or copying off the board, and consequently, they believed that they learned more. They were also able to do related activities like *make your own rocket* and they *relaxed* while they were learning.

It is better than sitting in a classroom, bored. You are actually actively doing something.

It was something different and fun to do ... and was better than writing all the time.

No need to hear teacher's voices again (unless you need help) and after everything has been read, it goes straight to your brain.

It allowed girls to move away from certain bigoted boys, thus allowing us to learn without having to hear their very boring life story.

Of the four scales of the WEBLEI, the Results scale is probably the most important, because it gives an indication of whether students felt that they had gained anything from their online learning environment. For this scale, means of almost four were achieved by both boys (*M=3.98, SD=0.61*) and girls (*M =3.89, SD=0.59)*, which suggested that students agreed they could establish the purpose of Web-based lessons. It was also easy to follow, well sequenced and clear. The structure of the Web site kept them focussed and helped them learn better the work that was done in class. The content was presented well and was appropriate for delivery in a Web-based learning environment. The tests at the end of the lessons improved their understanding in the subject.

Responses to questions in the written survey suggested that many students believed that the design and layout of the Web site increased their understanding of the concepts covered in their science lessons. They felt that *Getsmart* not only reinforced content but helped them to look at the content from a different source. One student claimed that such an approach made the class *open-mined* and enabled to *look into new opportunities of learning*. Another student believed that *Getsmart* improved marks, widened knowledge of science and was more than a normal science lesson. These perceptions reflect aspects of the Results scale of the WEBLEI.

The Web pages are presented in a manner that is easy to follow. You can re-read what you do not understand, is put in a way where the content is ... in appropriate categories ... you can find your weaknesses.

Achievement in Science

For many people exam results are regarded as the best indicators of how successful an educational initiative is. Therefore, the success of an innovative approach could be measured by comparing exam data with exams previously completed. However, school assessment instruments are continuously changing which makes reliable data comparisons very difficult. Other important variations also occur such as teachers changing from one year to the next and the variety in their expertise in the subjects can vary.

The students who participated in this project studied units on consumer science and chemistry in

Table 2. Analysis of mid- and end-of-semester results for boys and girls in year 10 science

Assessment type	Difference in the means#	Standard deviation (girls)	Standard deviation (boys)
Traditional learning group ($N = 214$)			
Knowledge (mid-semester)	8.73*	18.20	22.36
Knowledge (end-of-semester)	3.42	19.70	21.37
Application (mid-semester)	-0.77	24.33	24.70
Application (end-of-semester)	3.61	33.21	34.50
Blended learning group ($N = 244$)			
Knowledge (mid-semester)	2.81	20.02	22.38
Knowledge (end-of-semester)	-2.08	17.87	18.03
Application (mid-semester)	0.92	22.45	24.27
Application (end-of-semester)	-4.01	29.34	30.60

Difference in the means equals the mean score of the girls minus the mean score of the boys.
* $p < 0.05$.

term one. In the second term, Web-based learning was introduced over a ten-week period and units on road science and space travel were taught in a blended environment. These units were relatively harder because the focus was on physics related concepts. An assessment of the degree of difficulty in this case was based on teacher observations and student results from previous years.

The tests were designed to measure student's abilities in three performance domains—*Knowledge, Science* and *Application Processes*. The *Knowledge* section of the test examined student's abilities to recall and apply their knowledge to simple situations. *Science Processes* measured their abilities to present and interpret data. The *Application* section measured their abilities to apply themselves in problem solving situations. The results obtained by students in the *Knowledge* and *Application* sections were compared because these were more readily available. The results in the *Science Processes* section included exam and laboratory report marks which made comparison difficult.

In this discussion the changes to student performance possibly because of Web-based learning, are based on the comparison of test results obtained by the students who experienced Web-based learning and those who were taught through traditional teaching methods the year before. Consequently these groups have been referred to as the traditional and blended learning groups. Table 2 presents mid and end-of-semester results for boys and girls in Year 10 science.

The data in Table 2 shows that the overall performance of girls in the traditional learning group was generally better than boys in both *Knowledge* and *Application* sections of mid and end-semester exams. An independent samples t-test showed that the difference in the means of the *Knowledge* results for the two groups in traditional learning group was statistically significant ($p<0.05$) with girls achieving a higher mean than did boys.

In the blended learning group, the girls did better than boys in both sections in their mid-semester exams whereas the boys reversed this difference in the end of semester exams. Even though the boys did better in the end of semester exam, the differences were small and statistically insignificant which suggests that the blended approach was as good as traditional teaching methods. Additionally the results did not show any gender bias. Qualitative data gathered from students suggested that there was an overwhelming belief that Web-based learning did make a difference to their performance in science.

I found that using the online learning technique was of great benefit to me when studying the *topics incorporated in science ... I believe this allows students to attain and remain in a state of mind that enables a better understanding of the course material ... In my opinion, the online course taken by the science class was highly beneficial to them and their results.*

The website helped me to learn ... I did well in the exam which is better than I expected.

Worksheets completed during the lessons acted like revision sheets for the exam.

Yeah! I only just passed last term, this term I got a B^+ or something. It was great! Internet lessons all the way.

FUTURE TRENDS

New research evidence suggests that the brains of girls and boys develop at different rates (Park, 2004). Consequently, children should be exposed to a variety of learning opportunities and teachers should actively look for innovative teaching approaches. According to Bill Gates (as cited in Levy, 2003, p. 49) "the digital era is far from fading ... it's only now getting interesting." Teachers have to find smart ways of blending these technologies into their lessons. But this should not be achieved at the expense of any group.

CONCLUSION

The findings of this study are significant in the "swinging pendulum debate" where one sex is perceived to be favoured more than the other in classrooms. Palmer (as cited in Bevin, 2002, p. 9), believed that the curriculum "used to be made for boys, but there are now a greater number of female teachers and this has led to discipline, curriculum, going ... more towards girls". In this instance, the Web-based learning environment appears to be a learning medium which is preferred equally by both sexes. Creating such fair environments must be pleasing to education authorities because it has the potential to create equal opportunities for all. The findings of this study warrant further research in this area.

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KEY TERMS

Blended Web-Based Learning: This type of learning involves a blend or mixture of traditional and Internet driven teaching methods.

Learning Environment Instrument: A tool designed to quantitatively measure aspects of a learner's learning environment.

Splash Page: This is the introductory page of a Web site. It describes and leads a user to the rest of the Web site.

Web-Based Learning Environment Instrument: An instrument that is designed to quantitatively measure aspects of a Web-based learning environment.

What Women IT Professionals Want from Their Work

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INTRODUCTION

Articles in the popular IT press that address the underrepresentation of women often claim that women IT professionals differ from their male counterparts in what they desire from jobs, suggesting that special understanding of women's work-related values is required to improve their recruitment and retention (e.g., Bentsen, 2000; Gotcher, 1999; Paul, 2001). Although a great deal of research has been conducted on possible value differences that may affect women's and girls' attraction to IT as a career choice, there is relatively little empirical research showing that women actually do differ significantly from similarly trained men in the importance they place on particular qualities of work. The tradeoffs IT workers may make across desired attributes and the challenges they face in achieving career goals, however, are likely to show differences along gender lines. More methodologically-rigorous and practically-oriented research in job attribute preferences could help organizations make the changes in job design and personnel policies most likely to increase the representation of women in IT.

BACKGROUND

In general, little is known about the effectiveness of recruitment and retention practices targeted specifically at a particular demographic pool of applicants, such as women (Barber, 1998). It is well established, however, that the fit between what an employee or applicant desires from work and her perception of what she has is an important driver of both attraction to a job and turnover, as shown by both research in human resource management generally and with IT professionals specifically (Jiang & Klein, 2002). Thus, a key question is whether there are job attributes that women, on average, value more (or less) than men.

There is a large work of research literature many decades old comparing men's and women's ratings of how much they desire particular attributes of paid work (often referred to as work values), conducted among the general population, with adolescents, and across various educational and occupational groups (see Konrad, Ritchie, Lieb, & Corrigall, 2000, for a review). Most of these studies have reported gender differences in preferences for at least some job attributes. For example, traditionally it has been widely thought that men value earnings and leadership more, whereas women are especially likely to value social factors such as the opportunity to help others. These beliefs are also found among IT professionals. For example, in a cover story in *Infoworld* (Gotcher, 1999) women IT professionals are described as valuing income less than they value work assignments that allow growth. This article is based on a survey sponsored by Women in Technology International that had no male respondents for comparison purposes, but the underlying assumption is that men *would* respond differently. A software vice-president is quoted to the effect that "it's very different if you're interviewing men or women; I don't get as many questions about money and stock options from women" (Gotcher, 1999, p. 7). However, whether this behavior means that women actually care less about money, or rather that they have been socialized not to ask directly for more (see Babcock & Laschever, 2003), has important implications.

In the most comprehensive review of job attribute preferences, Konrad et al. (2000) conducted a meta-analysis of over two hundred studies, and found statistically significant gender differences for many attributes, generally consistent with gender roles and stereotypes. They note, however, that the effect sizes tend to be small, and that many masculine-typed job attributes, such as prestige and recognition, have become relatively more important to women in recent years, suggesting that aspirations have risen as barriers to equal opportunity have lessened (Konrad et al., 2000).

It is also true that reported job attribute preferences may be shaped at least partially by work and life experiences. Many researchers (e.g., Rowe & Snizek, 1995) have argued that gender differences in job attribute preferences are negligible once such factors as occupation and socioeconomic level are taken into account, which many studies have not done. Konrad et al.'s (2000) meta-analysis did include an analysis of studies of matched adults working in male-dominated occupations. In this subcategory, women rated several feminine-typed items, such as working with people, more highly than men, but they also rated many masculine-typed items, such as earnings, leadership, and challenge, *more* highly than their male counterparts. Most gender effects were small, and suggested a net pattern of greater similarity than difference among men and women currently working in the same predominantly masculine professions.

Research in this area conducted specifically on IT populations by IT researchers is relatively sparse, and the methods used sometimes make comparisons and conclusions difficult. Igbaria, Greenhaus, and Parasuraman (1991) surveyed several hundred members of the Association for Computing Machinery and classified each respondent according to which of eight possible career orientations he or she assigned the average highest score; thus men's and women's average ratings for various job attributes were not given. Igbaria et al. (1991) reported that a much higher proportion of women than men were primarily "life-style integration" oriented, defined as having an emphasis on family concerns and self-development. Conversely, a higher proportion of men were found to be technically oriented (primarily focused on the intrinsic technical content of work). The reported gender differences, however, were not analyzed controlling for type of work within IT or organizational level.

Other research suggests that men and women in IT might not differ significantly in what they desire from a job. Smits, McLean, and Tanner (1993) surveyed recent information systems graduates (IS) from over thirty U.S. colleges and universities and found that the similarities in desired job characteristics between men and women greatly overshadowed the differences. This study, where respondents had similar educational backgrounds and work tenure, also controlled for achievement level, and supports the argument that men and women are less likely to report significantly different preferences when they are similar on relevant factors.

Likewise, in a recent study conducted by the current authors (details available upon request), we surveyed IS alumni from a single program who had received their bachelor's degree within the previous five years. Men and women respondents did not differ significantly on the importance they placed on any of seven job attributes, including income, opportunity to develop technical skills, leadership opportunities, or social climate. Interestingly, both men and women on average rated work-life balance as most important.

After analyzing a broad survey of IT workers within the United Kingdom who rated the importance of several factors when choosing a new job, Panteli, Stack, Atkinson, and Ramsay (1999) concluded that women's responses were essentially similar to men's, with both men and women most likely to rate "job interest" and "challenging" as very important.

FUTURE TRENDS

Methodological Concerns

One problem with research on "what women in IT want" is that it relies on subjective ratings of very generally described job attributes. Typically, survey respondents are asked to rate the importance of each of a series of factors, such as responsibility, job interest, income, and promotional opportunities. However, priming artifacts and social desirability effects may limit the conclusions we should draw from such direct self-report data. Gender socialization and gendered social structures may affect both self-concept *and* self-presentation (see Konrad et al., 2000), and so the tendency for people to respond to such surveys in accordance with perceived social desirability (which, in turn, would be influenced by gender stereotypes) may be problematic.

Nor is it obvious what a respondent who rates "challenge" as more important than "income" would actually do when making career-related decisions. If we do not know how she defines those two attributes, or what she considers an adequate level of income or challenge, we cannot make predictions about the tradeoffs she would make in pursuing one job opportunity over another. It also remains a possibility than men's and women's subjective interpretations or definitions of such terms might differ. For example, it has been observed that women in IT tend to receive lower salaries than men, even when education and experience are controlled for, but that women do not report being any less satisfied with their compensation (see Baroudi & Igbaria, 1995; Sumner & Neiderman, 2003). This does not necessarily mean that women value income less than men, but may mean that their reference points differ from men's, or that their expectations (as opposed to aspirations) may rationally be lower.

Both in-depth qualitative studies and more sophisticated quantitative techniques may be better suited to revealing meaningful, and possibly subtle, gender differences in desired job attributes. For example, policy-capturing (also called conjoint analysis) designs derive the objective decision weights of a variety of independent factors, such as specifically defined job attributes, from an individual's global response to each of a series of combinations of those factors. As applied to job attraction, policy capturing provides a concrete, multi-attribute decision context, reduces social desirability effects, and links attribute information directly to the job choice criterion (see, for example, Zedeck, 1977). Other experimental designs could be used to see, for example, whether men and women IT professionals respond differently to various manipulations of advertised job descriptions. With between-subjects designs, where each individual participant responds only to one version of a job advertisement or description, social desirability and priming artifacts are again less of a problem.

A second major concern in studying gender differences in job preferences is the substantial segregation in the types of work men and women perform within the broad category of information technology, with women especially underrepresented in higher-paid IT jobs and more commonly found in categories such as help-desk workers (Igbaria, Parasuraman, & Greenhaus, 1997, Panteli et al., 1999). Whether this results from women choosing different types of work in accordance with their values, or whether self-reported values might be shaped at least partially by the type of work people are engaged in, or the extent to which both are true, are questions that cannot be adequately addressed by single-shot surveys. There is a clear need for more longitudinal research tracking individuals over time.

The Igbaria et al. (1991) study discussed earlier, a one-time survey administration, found that respondents with different career orientations tended to work in different types of IT jobs. For example, technically-oriented employees were especially likely to work in fields such as software engineering, whereas lifestyle integration-oriented respondents were found to be especially likely to work as applications programmers. Although the authors note that an individual's career orientation may not crystallize until she has significant work experience, they also claim that individuals' values cause them to gravitate toward compatible positions. Thus they suggest that because women are more likely to primarily value work-life balance, they may prefer jobs requiring less time commitment. In a later paper, however, Igbaria et al. (1997) noted that differences in career orientations in this sample could not explain women's underrepresentation in IT managerial positions.

Interestingly, Sumner, and Niederman (2003) reported that men and women graduates of IS programs did not tend to differ appreciably in types of work tasks performed. In our recent survey of IS alumni mentioned earlier, we also asked respondents to rate the attractiveness of three potential types of jobs within information systems, assuming they were to search for a new position. Both men and women rated an analyst position as most attractive. Women, however, did rate a service-oriented position somewhat more positively than did men.

Ideally, though, research following individual men and women over time would be best suited to answering the important question of whether inherent preferences and work values, or outside factors, best explain observed differences in career outcomes and occupational segregation within IT. Longitudinal research could also be used productively to assess the impacts of changes in family responsibilities on individuals' reported preferences, as well as their career choices and outcomes, and the related impact of work-life programs.

Research Needs

We suggest that research aimed at finding out what women in IT want from their work could have a much greater impact if it focused on particular aspects of job design and on work-family personnel policies. Rather than just assess subjective ratings of desired attributes, such research would focus on specific, practical options organizations could choose to target recruitment and retention efforts toward women. For example, in our survey of IS alumni mentioned earlier, on average both men and women respondents rated work-life balance as their most important criterion. However, women's actual experience seemed to differ from that of men, in that many more women rated their employing organization as not supportive of work-life balance. This again suggests that subjective ratings of generally described job attributes are insufficient to capture the experienced meaning underlying individuals' job-related preferences and decisions.

Many IT personnel researchers (e.g., Igbaria et al., 1997) have noted that women employees are more likely to carry a heavier burden of domestic labor, in terms of providing care to partners, children, and elders, than are men. Although men are increasingly assuming a greater responsibility for child-rearing, the imbalance is still marked and likely to remain so for some time. Personnel practices such as offering job shares, corporate day care, and part-time consulting work are recommended to organizations seeking to promote work-life balance, with the expectation that these options will be especially appreciated by women. However, there is relatively little hard data on how these policies are viewed by IT employees and applicants, and what impact they have on women in particular.

One common organizational response to work-life concerns is to offer more flexible work arrangements, in terms of either time or the space where the work is performed. The option to telecommute is particularly relevant to IT workers. It is commonly assumed both that such arrangements will tend to attract women and, because they can better balance their work and family concerns, to retain them. However, the actual effects of such policies may not be so straightforward. Rau and Hyland (2002) examined the effectiveness of flextime and telecommuting in attracting employees by randomly assigning respondents (employed MBA students) to read different versions of a hypothetical job. Those with high role conflict between work and family were more attracted to organizations offering flextime, but were *not* more attracted to work offering telecommuting. Thus, "employers who believe telecommuting will be attractive to job seekers because it will reduce high levels of role conflict may find it ineffective in attracting the very applicants it targets" (p. 133). Similarly, Hill, Miller, Weiner, and Colihan (1998) did not find that telework helped employees balance their work and personal lives.

Research on telecommuting by IT researchers has typically focused on productivity and performance evaluations rather than effects on employees' home lives or attitudes. How telecommuting affects IT professionals' attraction, attitudes, and retention is thus an important topic for future research; a particular need would be the careful comparison of different types of telecommuting arrangements and methods of implementation. For example, the effects of telecommuting full-time vs. only one day a week are likely to be quite different.

As we noted earlier, IT personnel research incorporating the effects of career changes and changes in family responsibilities over time would be especially useful in assessing the practical impacts of work-life policies. As an illustrative example, a recent longitudinal study by Konrad (2003) of MBA students showed that preferences for short, flexible work hours predicted hours of household labor years later. Moreover, this relation was stronger for women than men, supporting the notion that women are especially sensitive to this factor even at "pre-need" stages of their career, in that they may be more likely to make plans for combining work and family. Interestingly, respondents performing a high degree of household labor did not have any corresponding reduction in their desire for high salaries and intrinsically rewarding work (Konrad, 2003).

It would also be useful to research whether there are significant gender differences in the effects of specific alternatives in job design. For example, if women do especially value social connections, then perhaps making work team-based might be especially useful in attracting and retaining women, as well as having other possible positive impacts. A recent article in *CIO Magazine* claimed that "[w]hat women want is a sense of purpose in their work. They also want to feel connected and needed" (Bentsen, 2000). While we would not dispute this, it seems likely that most men would value these factors as well. In fact, task significance—the perception that one's work has an important impact on others—is a key component of the most widely applied motivational-based job design model. Although many job characteristics might be unlikely to differ significantly in terms of their impact on men and women, the widespread belief that men and women in IT are motivated by different factors warrants further investigation, both to establish which differences may exist and which do not.

CONCLUSION

What IT employees most want from their jobs will naturally vary a great deal from person to person, depending upon values, personalities, backgrounds, current circumstances, and expectations. Although many IT academics and practitioners have suggested that men and women employees value job attributes differently, we would agree with other writers on gender and IT (Trauth, 2002) that the essentialist position (i.e., the view that there are essential fixed male and female characteristics) is unsupported in this area. The similarities in desired job attributes between men and women, particularly those with comparable training, probably greatly outweigh any differences. Nevertheless, the tradeoffs IT workers may be willing to accept in achieving their career goals, and the challenges they are most likely to face, may tend to show differences along gender lines. Research geared toward investigating specific policies organizations could actually choose to implement, and which is aware of the methodological limitations of relying solely on subjective ratings of generally described attributes, could therefore have great potential in improving the attraction and retention of women in IT.

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KEY TERMS

Flextime: Any of a variety of temporally flexible work arrangements in which employees are allowed to schedule their own working hours, generally given specific parameters and limits.

Interrole Conflict: The extent to which the expectations of different roles held by an individual are incompatible, for example work interfering with family life and vice versa.

Job Attribute Preferences: The importance placed on particular qualities and outcomes of paid employment; often referred to as work values.

Job Design: The way the content and tasks of a job are organized, including what tasks are done, as well as how, when, and where.

Targeted Recruiting: Recruiting efforts aimed at a particular group of potential applicants, often members of an underrepresented demographic.

Telecommuting: Performing work at a site away from the office, and transmitting the work electronically.

Work-Life Balance: Finding satisfaction with life both inside and outside paid work, and effectively managing job responsibilities as well as family life and/or other important activities.

The Woman Problem in Computer Science

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INTRODUCTION

The longstanding concern about the absence of women in science and engineering in most Western countries has led to much research (see, e.g., Etzkowitz, Kemelgor, & Uzzi, 2000; Zuckerman, Cole, & Bruer, 1991). Today, this is all the more striking since women constitute the majority among students at most Western universities (Quinn, 2003). This article will briefly review research that analyses the lack of women in computer science, with a focus on higher education.

BACKGROUND

The substantial attention given to gender aspects of computer science reflects the significance of computers as a gateway to the emerging information society and the concern about a gendered digital divide. Women should take part in the design of this key technology, not remain users (Bjerknes & Bratteteig, 1987; Green, Owen, & Pain, 1993; Perry & Greber, 1990). The issue has been addressed by many women computer scientists, struggling to get more women into computing. Particularly in the U.S., a range of organisations and private initiatives have dealt with women and computing issues (Henderson & Almstrum, 2002). Australia and many North-European countries have also witnessed many such initiatives, often originating within government bodies.

MAIN THRUST OF THE ARTICLE

The so-called woman problem in computer science was discovered in the early 1980s through observations that young women took less interest in computers than young men (e.g., Dambrot, Watkins-Malek, Marshall, & Garver, 1985). Also, complaints that computer science offered a chilly climate to women students began to surface. Women students and faculty were perceived as women rather than as professionals, they were often treated as invisible, they met with patronising behaviour, and their qualifications were doubted. Also, their social environment was characterised by misplaced expectations, unwanted attention, and even obscenity (Barriers to equality 1983).

The main issue has been the question "why so few?" The explanations invoked may be classified in different ways (Ahuja, 2002; Cronin & Roger, 1999, Dryburgh, 2000, Littleton & Hoyles, 2002, Wilson, 2003). Striking metaphors have been employed to portray the situation, like "the incredible shrinking or leaking pipeline" or "the Silicon Ceiling." For the purposes of this article, contributions have been categorised under the following headlines, which summarize the varied understanding of the woman problem in computer science:

- Women's deficits
- Deficits in the educational practices of computer science and its student culture
- Discriminatory practices and other minority problems
- The masculine image of computer science

In the following sections, I will review research relevant to each of these categories. Please note that some contributions may belong to more than one of the categories, even to all of them.

Women's Deficits

Research has claimed that women have weaker computer knowledge and lesser computer experience, rendering an image of women as more computer anxious (Brosnan, 1998), less confident about their computer skills (Beyer, Rynes, & Haller, 2004; Borge, Roth, Nichols, & Nichols, 1980; Maccoby &

Jacklin, 1974), lacking self-efficacy in relation to computer science (Durndell et al., 2000, Galpin, Sanders, Turner, & Venter, 2003), alienated or just not interested in computers or computer science (Rasmussen, 1997; Siann, 1997; Symmonds, 2000). In this way, an emerging deficit model has become empirically grounded in comparisons with men's use of computers. Women were seen as deviant because men were regarded as the norm (Kramer & Lehman, 1990).

Consequently, a main argument has been that women needed to catch up with men by gaining access to computers and the related set of technical skills (Gansmo, 2004). In this manner, computer science was understood as a neutral set of skills to be acquired. Getting women into the discipline was a matter of "compensatory strategies," like providing better information and encourage girls and women to enter the field (Cronin & Roger, 1999; Henwood, 2000).

Turkle (1988) claimed that women's computer reticence emerged from their unwillingness or even fear to engage with a machine that was seen as intimate. However, her study of the early emerging Internet culture (Turkle, 1996) suggests a change, since women seem as eager as men to perform on the net.

Deficits in Educational Practices

Deficits in educational practices have been identified as obstacles to women to succeed and remain within computer science. Particularly the view that women, more than men, need to learn in a meaningful, goal-oriented and contextualised way, has been a common critique against programming courses. They have been seen as repetitive, playful, and meaningless exercises (Balcita, Carver, & Soffa, 2002; Countryman et al., 2002; Margolis & Fisher, 2002). To raise the quality of computer science teaching seems important to recruit and retain women students. This goal may be achieved by employing faculty that enjoy teaching undergraduates and by maintaining a stable faculty (Cohoon, 2002), by employing better qualified faculty, and by using more resources to hire teaching assistants and to provide better technical facilities and support (Lagesen, 2005; Margolis & Fisher, 2002; Roberts, Kassiandou, & Irani, 2002). To supply more women role models is generally seen as vital (Richardson & Kavanagh, 1997; Roberts et al., 2002; Townsend, 2002). Also, the importance of networking and support communities has been emphasised (Gabbert & Meeker, 2002).

Discriminatory Practices and Other Minority Problems

As mentioned, being a minority of women in an environment dominated by men is observed to be a major problem for women in computer science (Berg, 2000; Dambrot et al. 1985; Spertus, 1991; Teague 2000). Minority problems are diverse and include discrimination and sexual harassment (Dambrot et al., 1985; Kanter, 1977; Spertus, 1991).

The Masculine Image of Computer Science

Many scholars have explored the assumption that computer science is masculine and consequently a turn-off for women. It has been argued that the discipline has emerged from and is associated with institutions and practices usually perceived as masculine, in particular mathematics. Many recognize this as the parent discipline of computer science (Dambrot et al., 1985, Gressard & Lloyd, 1987; Mahony & van Toen, 1990). When mathematics is unattractive to women, arguably, computer science would be too (Kvande & Rasmussen, 1989; Mahony & Van Toen, 1990; Stepulevage & Plumeridge, 1998). A parallel argument is that computer science technology grew out of the military (Edwards, 1990; Mörtberg, 1987).

Some has advocated to broaden the scope of computer science, from the belief that this would attract more women (Salminen-Karlsson, 1999). To include social and organisational aspects of technology, social issues, and contextualised computer science has been assumed to make computer science more woman-friendly (Clegg & Trayhurn, 1999; Henwood, 2000; Siann, 1997). There are observations that computer science programmes located in social science or humanities environments have a much higher proportion of women (Kvande & Rasmussen, 1989).

A different approach to the presentation of computer science as masculine emerged through the 1990s, when one became concerned with its culture.

The occupational culture of computing has been seen as alienating to everyone who are not enthusiastic about computers (Sproull, Kiesler, & Zubrow, 1987), and it has been characterised as masculine (Wright 1996). Another main finding has been the impact of what was seen as a new form of masculinity, described by reference to hackers, nerds, or geeks (Berg, 2000; Kiesler, Sproull, & Eccles, 1985; Margolis & Fisher, 2002; Rasmussen & Håpnes, 1991).

The image of computer science has been found a vital impediment for women pursuing an IT career. Particularly among young girls, computers, and computer science has been perceived as nerdy (Rasmussen, 1997; Rasmussen & Håpnes, 2003).

Non-IT women graduate students perceived computer science as offering an unwelcoming classroom or workplace environment for women, compared to other fields (Weinberger, 2004). Another U.S. study found that computer science students were seen as unsociable and nerdy, compared to students in other disciplines (Beyer et al., 2004; Jepson & Perl, 2002). A common observation is that computer science is considered more difficult by women than by men, and that women perceive themselves (inaccurately) to be less competent (Corneliussen, 2002; Nordli, 2003). Beyer et al. (2004) found women students more interpersonally oriented than men. Women valued careers that would allow them to help others, to work with people, and to provide opportunities to combine career and family. Computer science was seen to be in conflict with these concerns.

FUTURE TRENDS

In addition, to be a gendered space, computer science is also found to be highly racialised (Galpin, 2003; Katz, Aronis, Albritton, Wilson, & Soffa, 2003; Leggon, 2003; Margolis, Holme, Estrella, Goode, Nao, & Stumme, 2003; Taylor, 2002). In the U.S., African-American women computer scientists constitute less than 3% (Taylor, 2002). Nevertheless, it seems that there are segments of women, based on nationality and/or ethnicity, that do opt for computer science careers. Culley (1986) noted that girls from single sex schools and of Asian origin enjoyed computing more than most other girls. An Australian study show that Asian women students outnumbered non-Asian women students. The Asian women were seen as better able to overcome the apparently hostile "international" computer culture (Greenhill, von Hellens, Nielsen, & Pringle, 1995). Margolis and Fisher (2002) observe that women students most likely to persist in the computer science programme were international students, primarily from Asia and Eastern Europe.

Schinzel (2000) shows that women's participation in computer science courses varies a great deal from country to country, from between 50% in South American, North African, and some East Asian countries, to 10-30% in the U.S., China, Russia, India, and countries in the southern part of Europe. The lowest percentage of 5-10 is found in Scandinavia, German-speaking countries, Japan, most African countries, and Australia. Galpin (2002) provides a statistical account of undergraduate and graduate students in computer science that shows the same pattern. Despite these overwhelming national differences, a common notion that there is a global masculine computer science culture that transcends national cultures, still seems to exist (Galpin, 2002; Suryia & Panteli, 2000; Wright, 1997). Lagesen's study of the situation in Malaysia (2005) shows that here, women constitute about half of the students in computer science at most universities. Also, she shows that computer science is not perceived as masculine subject, but rather considered as a career particularly suitable for women. Here, women computer science students told they wanted to pursue an academic career within computer science because it provided a relatively flexible job situation.

CONCLUSION

The literature reviewed here provides a varied set of explanations of the phenomenon that so few women choose to study computer science. As argued previously, the main reasons given for this problematic situation may be categorised under these four headings: women's deficit, deficits in the educational practice, discriminatory practices and other minority problems, and the masculine image of computer science.

However, it is striking how the woman problem in computer science has been understood mainly as an issue of exclusion. With a few exceptions (see Berg, 2000; Nordli, 2003; Lagesen, 2005), we are left with little knowledge about why women who actually decided to study computer science, have done so. Lagesen (2005) finds that, generally, Norwegian women computer science students are motivated by an interest in science and mathematics, in addition to the prospect of secure and well-paid jobs. The Malaysian counterparts in Lagesen's study have similar motives, but they are also induced to study computer science through outspoken parental advice as well as through a perception that computer science is a well-suited occupation for women.

Future research in the area should pay more attention to what may attract women to computer science, instead of focusing solely on exclusion. Disseminating results from research that has focused on women's positive relationship to computer science may be important to change or modify the widespread notion that women do not belong in this field. Also, an important lesson to be learnt from the case of Malaysia, is that a large share of women among the student population seems to dissolve the otherwise widespread symbolic identity between computer science and masculinity. Thus, we may be less pessimistic in our strive to get more women to into computer science.

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KEY TERMS

Chilly Climate: Environments in class rooms or work places, where individuals are often treated differently because of their gender, race, age, or other "outsider" status. A chilly climate can have a damaging cumulative effect that affects for instance women's self-esteem, aspirations, and participation.

Computer Science: The scientific study of computers and their use.

Education Deficit Model: Weaknesses and flaws in the educational systems and practices in computer science that works to disadvantage women in particular.

Exclusion Perspective: To emphasise the factors that tend to keep women out of computer science.

Hacker: A stereotypical description of a person, usually a man, very much engaged with computers, highly skilled but with low interpersonal qualifications.

Inclusion Perspective: To emphasise the actions that may bring more women into computer science and retain them, including the motives and actions of the women themselves.

Masculine Image: The idea that computer science is somehow better suited for men than for women.

Role Model: A person with skills and appearances that one finds attractive and may try to emulate.

"The Shrinking or Leaking Pipeline": Refer to a pattern where the number of e.g. women in computer science are systematically being reduced as they move to higher levels in the educational system.

"The Silicon Ceiling": A variant of the "glass ceiling", which is a metaphor for an invisible barrier for women's upward career mobility.

Women's Deficit Model: The view that women lack certain qualities, like knowledge, skills or self-esteem, which should be corrected in order to have more women become computer scientists.

Women and Computing Careers in Australia

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INTRODUCTION

In spite of predictions that the spread of information technology (IT) would help break down the gender segregation that characterized employment in the industrial era, women are under-represented in professional computing occupations throughout the advanced industrialized world, and those who do take up work in the IT sector are most likely to be found in routine and comparatively low paid jobs. The emergence of a "lighter, cleaner, and more sedentary set of occupations than the technologies of iron, oil and steam" (Cockburn, 1985, p.2) has certainly produced new jobs for both women and men, but—as Cockburn argues—gender inequalities have been reshaped rather than eradicated in this process of technological change.

The aim of this article is to extend existing knowledge about gendered employment patterns in professional computing with an examination of the situation in Australia in the early 21st century. Drawing on research conducted as part of a project funded by the Australian Research Council (Whitehouse, Hunter, Smith, & Preston, 2002-5), the analysis illustrates the types of computing jobs that women are most likely to enter, and the extent to which women are ascending career ladders to take up senior technical and/or management positions. While this is primarily a descriptive exercise, it produces a more nuanced picture of gender inequalities in IT employment than observations simply about under-representation, and allows some reflection on strategies to enhance opportunities for women.

BACKGROUND

Feminist analyses have long drawn attention to the "historical and cultural construction of technology as masculine" (Wajcman, 1991, p. 22), with a wide range of studies examining the processes that underpin the reproduction of gender inequalities in IT-related employment. At one end of the spectrum, attention has been paid to the way gender differences are developed in the recreational use of computer technology, as well as in the "educational pipeline" (see, among many, Greenhill, von Hellens, Neilsen, & Pringle, 1996; Henwood, 2000; Margolis & Fisher, 2002). Within the workplace itself, analysis has focused on issues such as masculine cultures and sexual harassment, gender-biased notions of skill, lack of informal networks and role models for women, and demands for skills currency and working-time pressures that restrict the ability to balance work and family (for example, Ahuja, 2002; Webster, 2004; Wright, 1996). Clearly, not all these phenomena are peculiar to IT employment, and within the IT sector there are also contrary propositions, such as an expectation that new IT firms may be less constrained by traditionally gendered culture and practice (see Panteli, Stack, Atkinson, & Ramsay, 1999), and recognition that the technology itself brings potential to maximize time and space flexibilities.

It is not the goal of this article to adjudicate between competing explanations or ascertain the compounding causes of gender differences in IT employment; rather the purpose is to provide additional detail on the shape of gender differences within the IT workforce. Much analytical attention has been focused at the level of occupational choice, with the problem identified broadly as women's under-representation in IT courses and employment. Here, the focus is on patterns within the labor market. In particular, the aim is to illustrate the *horizontal segregation* of men and women across IT occupational categories, as well as *vertical segregation* between status levels within these occupational categories (see definitions at the end of the article). While a global picture of segregation can be identified (for example, with processor assembly work performed largely by women in poor countries), this article is limited to the Australian case and high-skill (or 'professional') computing jobs.

AN AUSTRALIAN OVERVIEW

The material presented below draws on aggregate level survey data to illustrate patterns of segregation in IT employment in Australia. Although a deeper understanding of the development and reproduction of gender inequality requires additional dimensions such as qualitative investigation of workplace culture and practice, it is only survey data that can provide the overview sought in this analysis. The first sub-section outlines the data used, noting its strengths and limitations. The second and third sub-sections address, respectively, patterns of horizontal and vertical segregation. While there is no attempt to establish causal relationships, the implications of the statistical overview are considered briefly in the final sections of the article.

Data

Data are drawn primarily from a commissioned survey of large IT firms operating in Australia (*Survey of Employment and Pay Rates by Gender in the IT Industry*) conducted by Classified Salary Information services (CSi) in November-December 2003. The intent was to produce a gender breakdown of employment and pay rates in a selection of skilled roles relating to the development, configuration and maintenance of computer systems, and for this purpose CSi utilized its comprehensive and regularly updated list of occupational roles and position descriptions in the IT sector. Responses were received from 77 of the 108 companies contacted, and this delivered information on 12,706 employees working in 106 designated occupational roles. The sample cannot be taken as representative of IT employment or computing professionals as a whole, because it only includes information on full-time employees and long-term contractors within the respondent organizations (although these comprise the majority of employees in all cases), and it excludes small IT firms and organizations in which IT is not the primary function. However, the data do provide a relatively comprehensive picture of regular employment in large IT companies in Australia, with an important advantage being the fine level of occupational detail available.

Additionally, data are drawn from the Australian Bureau of Statistics (ABS) 2001 Census of Population and Housing. This provides a useful backdrop for the CSi data, with the main advantage of the census being the statistically reliable picture it provides of the Australian population. However, the standard occupational classification system used in the census lacks the finely detailed categorization of IT jobs in the CSi survey, hence observations from the census are limited to the 4-digit occupational category "Computer Professionals" and some of its constituent sub-groups.

Horizontal Segregation

In Australia, as elsewhere, there is marked horizontal sex segregation within IT-related employment at a broadly inclusive level (that is, where IT employment is defined as ranging from occupations involving routine use of computers, to the design of IT systems and software). For example, data from the 2001 Australian census show that while women made up only 23% of computer professionals at that time, they were over-represented in lower paid areas of IT-related work such as data entry, where they accounted for 85% of employees. As would be expected, a more homogeneous picture was evident *within* the category "computer professionals", although the census data do indicate some variation among the sub-categories, with women more likely to be "systems managers" (close to 30% of this group was female) than "systems designers" (around 18% female).

The degree of variation observed is clearly dependent on the level of occupational definition; thus horizontal segregation is more apparent within the comprehensive list of computing jobs covered in the *Survey of Employment and Pay Rates by Gender in the IT Industry*. Women accounted for 22% of employees covered in this sample, which—as noted earlier—includes skilled jobs associated with the design and maintenance of computer systems, but excludes jobs based solely on the routine use of computers such as data entry. While this overall percentage of women is similar to the figure for computer professionals in the census data, within the occupational roles included, female share varied from under 10% for a range of support engineer roles to over 60% of employees in areas such as technical writing.

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It is not possible here to examine differences across all 106 occupational roles included in the survey, hence attention is narrowed to selected groups of occupations, each comprised of a set of associated occupational roles classified by "career level" on the basis of the level of skill and responsibility required. Seven such groups were selected for examination, together accounting for 8,075 (64%) of the employees described in the sample. In ascending order of female share, these groups are: support engineers; consultants; software developers; technical analysts—specialized support; test analysts; and technical writers (definitions are provided at the end of the article).

Table 1 shows the marked variation in female share between these groups—from 9% for support engineers through to 64% for technical writers. Although explanations for this picture of horizontal segregation cannot be assessed within the scope of this article, they are likely to include differences in educational pathways and occupational histories, and gendered assumptions that reinforce women's location in support roles.

The extent to which this level of horizontal segregation is disadvantageous to women is not clear from Table 1, which provides no clear indication of a linear relationship between female share and average pay levels. For example, the groups with the lowest and highest female share—support engineers and technical writers—record very similar average pay rates. However it is also apparent that the two occupational groups with very high female share, test analysts and technical writers, are towards the lower end of the pay distribution. Most importantly for this article, horizontal segregation figures can conceal disadvantage that becomes apparent once vertical divisions are uncovered.

Vertical Segregation

Three of the groups presented in Table 1 (consultants, software developers, and technical analysts) are examined in more detail in this sub-section to show their constituent career levels and—for the latter two groups—associated management roles. The three groups were selected because they have clear career ladders and sufficient numbers of women to illustrate vertical segregation.

Table 2 presents the data for consultants, showing that although women are relatively well represented in career levels two and three (31%, compared with the survey average of 22%), female share is much lower in career levels four, five, and six. As the table also shows, high career level consultancy jobs are relatively well paid, and thus women's limited career progression has clear ramifications for gender equity.

A slightly different picture is evident for software developers (see Table 3). As with consultants, women's representation is above the survey average at the entry level role—programmer (see also Baroudi & Igbaria, 1995), but the career and pay ladders are not as steep within this group, and there is a separate group of project management positions. Women's representation is fairly consistent within the software development group of roles, with the exception that they are more likely to

*Table 1. Female share and average pay in selected computing occupational groups, Australia 2003**

Occupational groups	% Female	Average pay relative to programmer **	*N (employees)*
Support engineers	9	125	*2043*
Consultants	26	180	*2850*
Software developers	26	141	*2256*
Technical analysts, specialized support	28	161	*743*
Test analysts	44	117	*144*
Technical writers	64	127	*39*
TOTAL SAMPLE	*22*		*12,706*

*Notes: * Data refer to full-time employees in large IT organisations; ** Average pay for the job role "Programmer"=100. Pay rates include taxable base salary and any salary sacrifice superannuation amounts made by the employee. Source: Survey of Employment and Pay Rates by Gender in the IT Industry, Australia 2003*

*Table 2. Female share and average pay for consultants by career level, Australia 2003**

Occupational roles	Career level	% Female	Average pay relative to programmer	*N (employees)*
Consultants				
Associate Consultant	2	31	105	*346*
Consultant	3	31	150	*1135*
Senior Consultant	4	19	203	*594*
Principal Consultant	5	23	214	*449*
Senior Principal Consultant	6	19	273	*326*

*Note: * See notes to Table 1*
Source: Survey of Employment and Pay Rates by Gender in the IT Industry, Australia 2003

*Table 3. Female share and average pay for software developers and project managers by career level, Australia 2003**

Occupational roles	Career level	% Female	Average pay relative to programmer	*N (employees)*
Software developers				
Programmer	2	29	100	*345*
Analyst Programmer	3	27	143	*909*
Senior Programmer	3	22	158	*778*
Systems Analyst	4	28	139	*224*
Software project managers				
Project Leader	4	32	145	*523*
Software Project Manager	5	22	190	*166*
Senior Software Project Manager	6	15	249	*79*

*Note: * See notes to Table 1*
Source: Survey of Employment and Pay Rates by Gender in the IT Industry, Australia 2003

be systems analysts than senior programmers, and although systems analyst is rated at a higher career level than senior programmer, average pay is lower. While these observations suggest the emergence of gendered pathways within the software development function, the degree of vertical segregation is not as marked as for consultants or software project managers.

The software project management roles included in the lower half of Table 3 show that women are much more likely to be represented in project leader than in senior management roles (see also Donato, 1990). Although project leader is classified as career level four, it is not particularly well remunerated (for example, average pay is lower than for level three senior programmers), and there is little evidence that it provides a well-used stepping stone for women into senior management.

The final group to be analyzed includes technical analysts and the management roles within technical support centers. Table 4 shows the marked vertical segregation that exists among technical analysts providing specialized support. While female share among associate technical analysts (career level two) is high at 41%, this declines with each step of the career ladder, reducing to 10% for principal technical analysts (career level five). Although there is not quite as wide a pay disparity between entry and senior level positions as that illustrated for consultants, career progression clearly brings significant financial gain. Among the leadership/management roles, there is again a clear distinction between team leader and senior management roles, both in female share (from 40 to 19%) and level of remuneration (centre team leaders at career level four earn less on average than level three technical analysts).

*Table 4. Female share and average pay for technical analysts and technical support centre management roles by career level, Australia 2003**

Occupational roles	Career level	% Female	Average pay relative to programmer	*N* *(employees)*
Technical analysts-specialized support				
Associate technical analyst-specialized support	2	41	108	*51*
Technical analyst-specialized support	3	26	143	*356*
Senior technical analyst-specialized support	4	14	172	*169*
Principal technical analyst-specialized support	5	10	206	*167*
Technical support centre management				
Technical support centre team leader **	4	40	130	*35*
Technical support centre manager **	6	19	239	*27*

*Note: * See notes to Table 1; ** Small numbers in these groups mean the results should be interpreted with caution.*
Source of data: Survey of Employment and Pay Rates by Gender in the IT Industry, Australia 2003

Overall, the data on vertical segregation have allowed a more detailed assessment of gendered patterns of employment in skilled computing work. They present a less benign picture than the more aggregated horizontal comparisons shown in Table 1, in particular showing that the types of management positions women are likely to occupy are rarely high paid senior roles.

FUTURE TRENDS

Australia, along with a number of other industrialized countries, is experiencing a decline in already very low levels of women in tertiary level IT courses—a trend with clear implications for women's future representation in professional computing work. Women made up a little over one-quarter of commencing students in IT higher education in 2001, but this fell to around 20% in 2004 (Australian Government, n.d.). This trend has been accompanied by a fall in absolute numbers in the IT student cohort. From 2003 to 2004, there was a 15% drop in the number of women studying IT at tertiary level, while at the same time the number of women enrolled in tertiary education overall increased by 2% (O'Keefe, 2005, p. 26). Although the focus of this article is on progression within IT employment rather than tertiary education trends, this decline is not without significance. For example, career prospects for women in areas of professional computing work where tertiary qualifications are the norm may worsen over time if there are fewer women to challenge masculine working cultures and bring equal employment opportunity issues onto the agenda. Additionally, to the extent that competitive pressures encourage long hours and discourage career breaks and working-time flexibility, and high levels of contracting out allow organizations to sidestep regulatory frameworks, the prospects for improving women's career progression in the sector remain limited.

CONCLUSION

In conclusion, this overview of gendered employment patters in skilled computing work in Australia indicates that the "women in IT problem" is not simply one of access, just requiring strategies to attract more women into the field; it is also one of career progression, underlining the need for workplace level arrangements to facilitate retention and advancement. This is not peculiar to IT employment, although the highly competitive nature of IT work and its strong masculine culture are likely to continue to make advances difficult. The problems are not immutable, however, and ongoing research identifying cross-national variations in segregation patterns and policy frameworks, as well as workplace and individual level studies illustrating the experiences and needs of those engaged in the IT sector, will continue to inform the pursuit of more gender egalitarian employment outcomes.

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KEY TERMS

All occupational definitions are based on position descriptions used in the *Survey of Employment and Pay Rates by Gender in the IT Industry* conducted in Australia in 2003 and may not be universally applicable.

Consultants: Employees with responsibility for evaluating clients' business needs, developing industry specific systems for clients, and liaising with them during installation and testing.

Horizontal Segregation: Shorthand for the notion of horizontal sex segregation in employment, which involves the separation or uneven distribution of men and women across different occupational groups, such as computer programmers and technical writers.

Software Developers: Employees who create and maintain computer programs, analyse software requirements and existing programs, and monitor new software developments.

Support Engineers: Employees who provide support to customers in the field or on-site, installing and repairing hardware and software.

Software Project Managers: Employees who control software development project schedules and quality standards, and report on costs and progress. Senior management positions may also involve control of budgets and the recruitment and training of staff.

Technical Analysts—Specialized Support: Employees who provide specialized technical support from a remote location by telephone or e-mail.

Technical Writers: Employees who present technical information in forms accessible to users, for example in manuals and online tutorials.

Test Analysts: Employees who prepare testing documentation and test programs.

Vertical Segregation: Shorthand for the notion of vertical sex segregation in employment, which involves the separation or uneven distribution of men and women across jobs of different status levels within the same occupational group, such as consultants and senior consultants.

Women and ICTs in the Arab World

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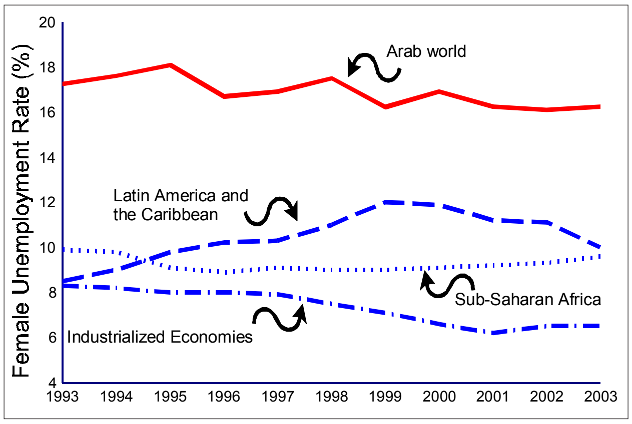
INTRODUCTION

The digital divide manifests itself on the one hand in the lag in Arab world nations vis-à-vis other more developed countries and on the other hand in the existing inequalities between men and women. Although the United Nations and the World Bank publish a variety of reports on the differences between developed and developing nations, very little data is available to fully grasp the meaning of the gap between genders. In terms of information and communication technologies (ICTs), there are two distinct gaps that need to be recognized: the gap between Arab men and Arab women and the gap between Arab women and women from other nations around the world (Figure 1).

Much differs in the lives of men and women. For decades, researchers have published comparative reports, attempting to explain what distinguishes men and women in socio-professional environments. According to Meyers-Levy (1989) men tend to be more comfortable with ICTs and partake more often in gaming and programming. When they use computers, women are more inclined to use them as communication tools. Given women's presumed lack of experience with technology, their upbringing which is different from men's, and that the studies they most often pursue are not technology-oriented, it is not surprising that women are generally less inclined to adopt new technologies. Those who nonetheless have tried their hand at browsing the Web were either witness to or victims of offensive language used during interactive discussion sessions; in some cases, they were harassed via e-mail. In order to avoid this unpleasantness, some women assumed male aliases (Herring, 2003). However, since 2000, when men and women reached parity in Web use (Rickert & Sacharow, 2000), it would appear that using the Internet is presently no more intimidating for females than for males.

An abundance of other differences between men and women exist. The United Nations Development Program (UNDP) acknowledged that there does not exist a society in which women benefit from the same opportunities as men. Everywhere in the world, women are poorer, less educated, and less valued than men. These and other inequalities reduce women's ability to take advantage of the potential benefits of ICTs and to consequently contribute to their nation's economic and social development which is in fact facilitated by these same technologies.

Figure 1. Female unemployment rates by region from 1993 to 2003



Note: In 2003, 40% of the world's 2.8 billion workers were women, representing a worldwide increase of nearly 200 million women in employment in the past 10 years. In the Middle East and North Africa, the female unemployment rate of 16.5% was 6% higher than that of men.
Source: ILO, 2004

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BACKGROUND

If a digital divide is known to exist between northern and southern nations, between developed and developing countries, between knowledge economies and emerging ones, and between the haves and the have nots, it also needs to be recognized that a greater, encompassing-all-of-the-above divide exists based on individuals' gender. In essence, a divide exists between men and women regardless of what other category into which they may fall.

The Gender Digital Divide

Although the gender digital divide may no longer be a concern for a few countries, namely Scandinavian nations, it is very much present in Arab countries where the effect is exacerbated: first, because of the general lag of Arab nations, second because this divide targets the gender which, according to most of the socio-economic-cultural criteria as defined by the UNDP in its 2002 and 2003 reports, is already at a disadvantage.

In December 1998, 34.2% of men and 31.4% of women worldwide used the Internet. In 1999, less women (48%) than men (52%) used the Internet, even in the U.S. In August 2000, it was reported that 44.6% of men and 44.2% of women were Internet users.

A 2002 study undertaken by eMarketer and appearing in the New York Times reported that from a professional perspective men preferred e-mail to the telephone; the opposite was found true for women. For both genders, face-to-face interaction was favored above all (54% of men and 47% of women). These results are in line with Herring's (2001) comments who argued that women prefer the Internet over face-to-face conversations since, traditionally, patterns of male dominance have been observed in face-to-face interaction. Similarly, Consalvo (2002) maintains that the telephone has come to be considered a "female medium" of communication.

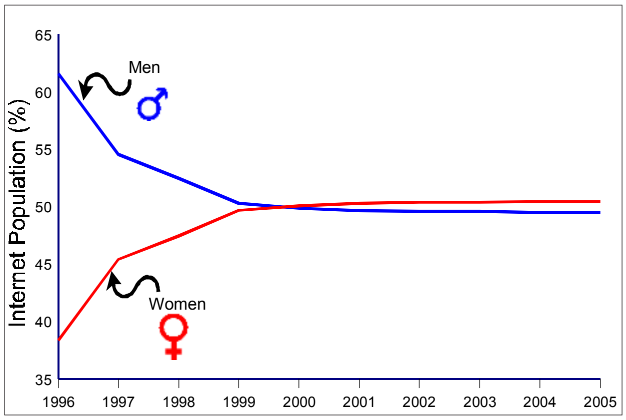
In 2003, a study by Nielsen/Netratings revealed that equality between European men and women Internet users was still far from reality. In 2000, this parity had been reached in the U.S. (Figure 2). According to the report, the Internet user population is indeed becoming feminized, albeit slowly. In 2002, 41% of European Internet users were women. In 2003, this number rose to 43%. At this rate, it will take until 2010 for equality in terms of the number of women and men Internet users in Europe to be reached.

Women in the Arab World

Arab countries have exhibited the fastest improvements in female conditions of any region of the world (UNDP, 2002). To illustrate, women's literacy rates have increased threefold since 1970 from 16.6% to 52.5% and female school enrolments have more than doubled. Today, women make up more than 70% of the student population in most Gulf-area universities. They represent more than 25% of judges in Tunisia (as compared with 20% of federal judges in the U.S.) and 10% of members in the Moroccan Parliament (as compared with 13% in the U.S. Congress) (Al-Hamad, 2003).

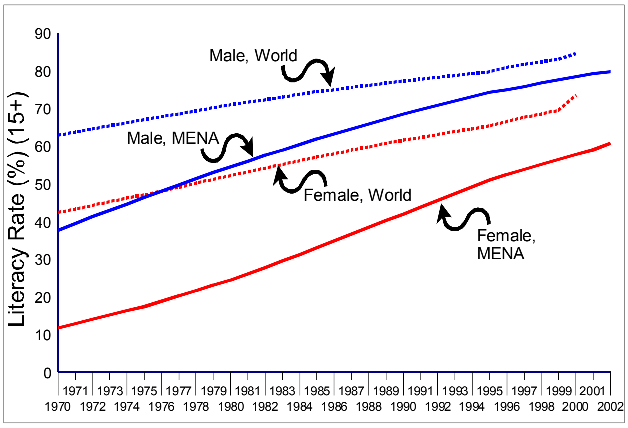
However, only 32% of women are active participants in their country's labor force, the lowest rate in the world (World Bank, 2004) (Figure 4). Though working women are generally more educated than their male counterparts, female unemployment is often highest among more educated women, who regularly leave the labor force to get married and have children (World Bank, 2004).

Figure 2. In the U.S., parity in Internet use between men and women was reached in 2000



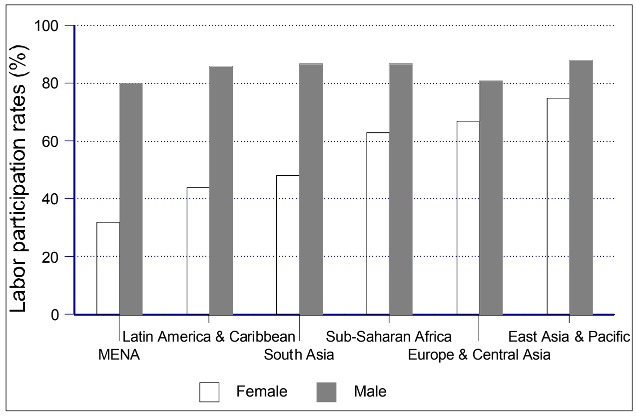
See Rickert & Sacharow, 2000; and eMarketer, 2000

Figure 3. The evolution of the literacy rate for Arab women as compared to that of men and to the world average



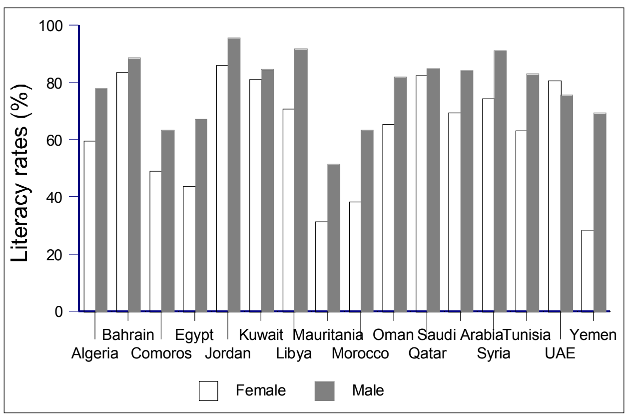
Source: World Bank, 2004

Figure 4. Male and female labor force participation, by region



Note: Despite this significant growth and despite the high potential for women to participate in the labor force, actual rates of participation remain among the lowest in the world.
Source: World Bank, 2004

Figure 5. Literacy rates of women and men in selected Arab countries in 2004



Source: UNESCO, The UIS literacy table (September 2004 release) applying to the reference period 2000-2004, www.uis.unesco.org

The 2003 edition of the UNDP report is a bit more pessimistic in that the quality of higher education was actually found to be declining and enrollments to be down. On closer examination, investments in education have actually declined since 1985. Even more alarming news is the fact that the average expenditure on R&D was a tiny 0.2% of GNP. Among the 65 million illiterate Arabs (of a total population estimated at 280 million), two-thirds are women (Figure 5).

The 2002 UNDP report already highlighted that the condition of women is one of the top three inadequacies in the Arab world. The 2003 report added that, in general, the utilization of Arab women's capabilities is amongst the lowest in the world both in quantitative and in qualitative terms. This inspired Christiaan Poortman, World Bank Vice President for the Middle East and North Africa (MENA) region, to state that "No country can raise the standard of living and improve the well-being of its people without the participation of half its population."

Arab Women and Information and Communication Technologies

Over the years, changes have also been sensed on the ICTs front, at least for younger generations. The introduction of Internet browsing and electronic messaging through Internet cafés extended across the Arab world. The World Bank estimates that over 8 million Arabs used the Internet by the end of 2002, compared with less than 40,000 in 1995.

When looking at ICTs and the Arab world, the picture is further complicated because gender and culture are confounded. The digital divide is thus doubled, even squared, in such a case.

A number of analyses, including those of the UNDP and the World Bank, report that the proportion of Arab women Internet users was 4% while the European average was 42%. This figure rose to 6% in 2000 and a few years later to 19-20% with peaks reaching 36% in the United Arab Emirates.

One could expect the Internet to be the preferred medium of communication for women in some Arab countries. Indeed, in other parts of the world the Internet has been claimed to lead to greater gender equality (Consalvo, 2002) because text-based computer-mediated communication would allow women and men to participate equally, in contrast with patterns of male dominance observed in face-to-face conversations and because it would allow women to find community in pursuit of their own interests (Herring, 2001). Furthermore, the World Wide Web would allow women to engage in entrepreneurial activities without transgressing socially constructed norms and rules such as those prevailing in the Gulf where men and women are not allowed to mingle.

FUTURE TRENDS

The ICT Skills Deficit in the West

In 2002, it was forecast that Western Europe would lack 1.6 million ICT specialists representing 12% of the demand. The same year, it was expected that France would have a need for 67,000 network specialists, England 31,000 and Germany 188,000. And the outlook, if anything, looks bleaker as demonstrated in a study reported in the French magazine Les Echos (2000) in which it was found that by the year 2010 the number of needed ICT engineers in France would reach 1.1 million.

The Brain Drain

Though brain drain has been a worldwide phenomenon since the 1960s, a UN agency suggested that between 1960 and 1987, 825,000 skilled immigrants entered the U.S. and Canada from developing countries (UNCTAD, 1987).

The UNDP (2003) estimates the number of Arab doctors having emigrated between 1998 and 2000 at more than 15,000 and that 25% of the 300,000 graduates from Arab universities in 1995-1996 migrated. Furthermore, it was estimated that a total of $13 billion was lost to the Arab world and African countries in the 1970s as a result of the brain drain. A further report by the Arab League estimated that the loss to the Arab countries was $200 billion, noting that Western countries are the greatest beneficiaries from hosting a number of 450,000 Arabs of higher scientific qualifications (Arabic News, 2001).

The brain drain is unevenly spread across the Arab region. North Africa and the Middle East suffer higher rates than the Gulf because of difficult socioeconomic conditions, lack of social incentives, limited employment perspectives, shortages in research budgets, and chronic technology underinvestment (Dutta & Coury, 2003).

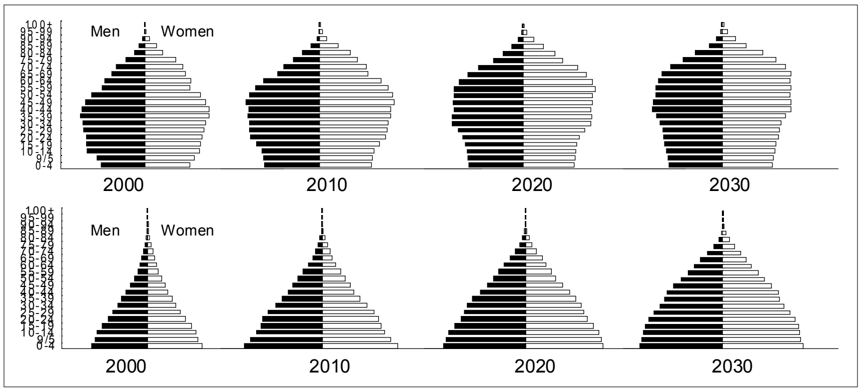
Losses are not just monetary since this is handled by the amounts of remittances sent home by the diaspora and which, in some cases, more than compensates for the brain drain (Adams, 2003). Adams shows that remittances sent to 24 developing countries (including Egypt, Morocco, and Tunisia) exceeded $500 million dollars in 2000. This is what has been known as the "brain gain" phenomenon whereby a more optimistic light is cast on the brain drain issue. The argument is that remittances, return of skilled migrants and development aid are noted as the ways source countries compensate for the loss of brains (Ramamurthy, 2003).

However, if Arab and developing countries invest heavily in educating young men and women, the consequences are readily felt when a sizeable segment of these migrates and never returns. When the migrants are trained in high-tech know how, the sending countries lose a great advantage because of the migration of labor, with the benefit accruing to the host countries that did not incur the cost of educating them (Asmar, 2003).

The Changing Demographic Scene in the Arab World

One of the most significant factors that developed nations will face in the next two or three decades is the aging of their population. Already between 1998 and 2025 it is estimated that the number of people 65

Figure 6. The age pyramids of the developed world (top) and of the Arab world (bottom) between 2000 and 2030



Note: As defined by the United Nations, the developed world is comprised of Europe, North America (U.S. and Canada), Australia, New Zealand and Japan.
Source: United Nations Population Division, World Population Prospects: The 2002 Revision Population Database, Graphics, and computations by the authors

years and older will double, while those less than 15 years old will rise by only 6% (Bureau of the Census, 1999).

One interesting fact is that the Arab world has the most significant proportion (37%) of youths aged 14 years and younger in the world (UNDP, 2002). In the last two decades, the population of the Arab world rose by an average 2.6% relative to the world average of 1.5%. This rate will continue to be above average in 2015 (2.1%) and in 2025 (1.9%) (United Nations, 2003).

North Africa's population grew from 140 million in 1990 to 157 million in 1995 and is likely to reach 211 million in 2010 (Cordesman, 1996). Libya, Morocco, and Tunisia where fertility rates are similar to those in European nations are expected to post populations of 8.7, 35, and 12 million, respectively (Cordesman, 1996). Furthermore, North African women tend to marry later than women from the Gulf countries (Fargues, 2002). However, typically where demographic demands are felt the strongest the greatest constraints are placed on the educational budget, infrastructure, health, water consumption, employment, and even social stability.

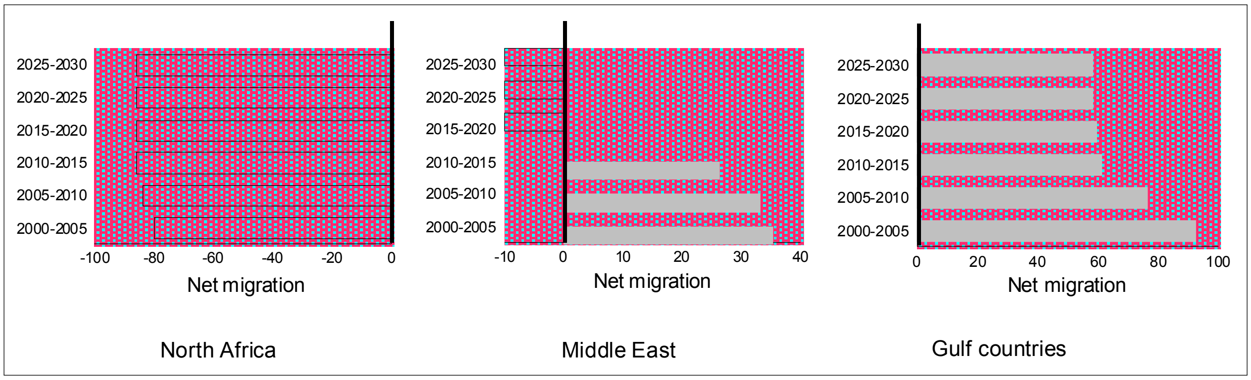
A cross-sectional poll of Arab youths conducted by the UNDP (2002) highlights the fact that nearly half (45%) the respondents expressed a desire to emigrate. In fact, close to 100,000 Arabs and Muslims emigrate to the West each year. The aging populations of Italy, Germany, Great-Britain, France, and especially the United States and Japan create a need for these immigrants (The Economist, 2002).

CONCLUSION

The effect of the demographic developments taking place in various regions of the world on the Arab world begs for our serious attention. In a decade or two, the youths of the Arab world will become even more valued than they have been since 1995. Furthermore, the part of the youths and talented individuals in the Arab world who are most mobile tend to be of the male gender (Hijab, El-Solh, & Ebadi, 2003). As western countries will be seeking new and innovative minds, there is a true possibility that all the investments made by Arab nations in the education and training of Arab engineers will be lost, practically overnight. In addition, the aging populations in the West will represent such a social burden on the governments that the fiscal pie will need to be enlarged and this will be done by rapid and substantial bouts of emigration and naturalization.

Women in the Arab world have an essential role to play in the economic and social development of their nations. If one can use history as a model for the future, the two World Wars correspond to the initial stages of women's emancipation in the West

Figure 7. While net migration rates (the difference between inflow and outflow of human capital) are already negative for North African countries, they will begin to be negative around 2015 for the Middle East



Source: United Nations Population Division, World Population Prospects: The 2002 Revision Population Database, Graphics, and computations by the authors

which was then followed by the 1970s feminist movement in the U.S. When men left for the war front and many did not return, the economic wheels could not afford to stop turning and it was the women who ensured that they did not.

Based on the rate of emigration of Arab youths and the need of western nations, what will be left of the Arab world will essentially be populations that are relatively less educated and less mobile. If we assume that a sizeable portion of the highly qualified and competent men of the Arab world will be lured away by the prosperous and captivating West, the reality we will then face is one where the role of the Arab woman will become much more important and crucial to the survival of the Arab world. Furthermore, this will not only apply to the domain of ICTs. If Gulf nations are assumed to suffer less than those of North Africa and the Middle East, then the women of the former will benefit most from added attention in terms of training and education, especially in the area of ICTs.

Because it would appear that the brain drain situation for the Gulf is not as serious as that of North Africa and the Middle East, it follows that it is women of the Middle East and North Africa (MENA) that need the most urgent attention.

Women should no longer be trained in word processing and other so-called "productivity tools" mostly destined to secretarial jobs but rather in the design of application systems, of Web sites and systems interfaces. Internet technologies might be the feminine "killer application" due to women's hypothesized communicational skills (Taggart & O'Gara, 2000). Training programs such as those launched by Cisco should become commonplace[1]. True technological learning extends beyond word and spreadsheet processing. Arab content owes itself to include women's interests; advances in business and electronic exchanges cannot discount the female gender in the Arab world.

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KEY TERMS

Arab World: Twenty-two countries and territories, namely: Algeria, Bahrain, Comoros, Djibouti, Egypt, Iraq, Jordan, Kuwait, Lebanon, Libya, Mauritania, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Somalia, Sudan, Syria, Tunisia, United Arab Emirates, and Yemen.

Brain Drain: the migratory movement of skilled labor from one country (the sending country) to another (the host country).

Digital Divide: the difference in access to and usage of information technologies.

Gulf States: Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and United Arab Emirates.

ICT: Information and communication technologies, including, among others, the PC, the Internet and the Web, mobile and fixed telephony, and their software and applications.

MENA: Middle East and Africa but usually includes the Gulf countries as well.

Middle East: Iraq, Jordan, Lebanon, Palestine, and Syria.

North Africa: Algeria, Egypt, Libya, Mauritania, Morocco, and Tunisia.

ENDNOTE

1 The scholarship program launched by the Cisco Networking Academy: Women In Technology is sponsored by the United States Agency for International Development (USAID) and managed by the Institute of International Education (IIE). Thanks to a grant from the Internews Network Dot-GOV program, the program grants scholarships to female candidates from Tunisia, Algeria, and Morocco allowing them to be Cisco Certified Network Associate (CCNA). The program trains in Web site design, database design, cabling, Java, Unix, etc. See the Women In Technology Scholarship Program (WIT) Web site (www.iie.org/wcoast/wit.html).

Women and Recruitment to the IT Profession in the UK

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INTRODUCTION AND BACKGROUND

Early commentary on the development of the field of Computing and its relationship to women was generally optimistic in tone. Many early software workers were female, and the associations of computing with a qualitatively different, and cutting-edge, technological domain, caused projections that women would comfortably enter professional Computing work in a manner unparalleled for scientific and technological occupations (Faulkner, 2002; Woodfield, 2000). The rationalisations shaping the decision of early female entrants to the field often mirrored those buoying up the optimism of commentators. An established female computer professional in the late 1980s, for instance, reported applying for her first job within the IT sector a decade earlier because she had believed the area to be "one of the first businesses with no sex prejudice" (Cowan, cited in *The Guardian*, 1989).

A review of the literature that chronicled the *actual* movement of women into IT work cross-nationally since these early predictions, however, leaves little doubt that women were quickly established as the under represented party within IT roles. As Elizabeth Gerver suggested at the close of the 1980s, Computing effectively became established as a "strangely single-gendered world," and although women's under-representation may have varied "from sector to sector and to some extent from country to country," the evidence of its male-domination and, indeed, its maleness, became so ubiquitous that it tended "to become monotonous" (1989, p. 483). A large body of work has underpinned the ongoing legitimacy of this observation since the 1980s (Faulkner, 2002; Hall, 2004; Millar & Jagger, 2001; Peters, Lane, Rees, & Samuels, 2003; Woodfield, 2000).

The Participation and Progress of Women in UK IT Occupations

Women are under represented within occupational roles within the UK IT sector, or IT roles in other sectors, and especially within the more prestigious and well-rewarded roles.

Their estimated numbers within the broad category of IT workers vary, but available statistics suggest that it is lower in the UK than in other countries, including the U.S. and Canada. Women, it is variously claimed, comprise between 13% and 22% of all IT workers, including those outside of the IT sector itself (see Faulkner, 2002; Millar & Jagger, 2001; Miller, Neathey, Pollard, & Hill, 2004; Sørensen, 2002). This represents a decline since the turn of the millennium (Faulkner, 2002; Millar & Jagger, 2001). Indeed, the president of the British Computer Society recently announced a 3% drop in female participation between 2002 and 2003 alone (Hall, 2004).

Female participation patterns in the UK follow global trends and are unevenly distributed throughout the sector and occupations. Best estimates claim women comprise only 16% of all IT managers, 21% of computer analysts, and 14% of software professionals (although less than 10% of software engineers). They are more substantially represented in the lower echelons of IT work as operating technicians, for instance, where they comprise approximately 30% of the workforce (EOC, 2001b; EOC, 2004; Miller et al., 2004).

Another characteristic of female participation, however, is that women are far more likely to work in an IT role outside of the IT sector itself. Indeed, it is estimated that they comprise only 9% of IT workers within the area (Faulkner, 2002; Millar & Jagger, 2001).

It is worth noting, however, that those women who find themselves joining the IT workforce are likely to experience slightly less severe gender pay differentials than women in other types of work. For instance, computer analysts/programmers can expect to be paid 7.7% less than comparable males, and IT managers can expect a lag of 12.1% behind their male peers (Miller et al., 2004). This compares well against the 18.4% average deficit that women experience more generally. The trend is for pay gaps to increase the further down the occupational scale IT roles are situated, but they are still marginally better than national averages for comparable work (Miller et al., 2004).

This does not, however, help retention rates, which are generally worse for women, including at the more senior levels. The most recent reports suggest that the industry is losing more female staff than it is recruiting (Computer Weekly, 2003; Grey & Healey, 2004; Hall, 2004).

Women's Propensity to Self-Select out of IT

One explanation for low female participation rates in occupational IT is women's propensity to self-select out of the field. The masculine nature of IT's culture and image has, rightly, been cited as a key reason underlying this tendency. Research suggests that the identification of occupations as either gender-appropriate or gender-inappropriate starts early (EOC, 2001a; Miller et al., 2004), and, as females progress through their education, they tend to drop out of subjects allied to gender-atypical careers with increasing frequency. Their over-representation within the lower echelons of the field may also, then, be partly related to their tendency to drop out of educational qualifications that are required for the more professional-level roles within it.

If this were the primary reason for the general picture of female participation and progression rates, however, we would expect women with professional-level IT qualifications to be present within the sector in terms broadly proportionate to comparable men. These women have bucked the gender trend and demonstrated their commitment and interest in the field by choosing to study an IT-related subject to a level that qualifies them for such a role.

The Progress of Women with Computer Science Degrees into Professional-Level IT Work (with Engineering as a Comparator)

An examination of the first occupational destinations of men and women graduating from university with computer science degrees[1] is a useful way of assessing whether women progress into professional IT work with the same frequency as men when they persist with their education in a subject that eminently qualifies them for it. To ascertain whether the conversion rates for Computing are part of a general Science pattern, or more specifically interesting, it is useful to compare them with conversion rates for men and women on a cognate degree programme: engineering. As with computer science, engineering is male-dominated both at the university and occupational level—more so in fact (Scenta, 2005), and also shares the characteristic of having a reasonably clear vocational link between degree-level study and professional work in the field.

Table 1 records the relationship between undergraduate programmes in computer science and engineering, gender and the occupation a graduate is within six months after graduating.

It can be seen that women fail to enter professional IT roles with the same frequency as we would expect, and with about half the frequency that comparably qualified males do. Moreover, over twice as many women as men with a computer science degree end up in an occupation within the non-professional category "administrative & secretarial", and they represent over a quarter of all women with this qualification. Indeed, women with a computer science degree are *more* likely to go into "administrative & secretarial" work than they are to convert their degree into a professional-level job within IT.

Additionally, 10% more women with engineering degrees make the transition to professional-level engineering work than women with computer science degrees make the transition into professional-level IT work[4]. Women with engineering degrees are also more likely to secure a professional level job in any sector. More generally speaking, female Computer Scientists provide the sole exception to the rule that sees women UK graduates more likely than male graduates to secure employment after graduating (Millar & Jagger, 2001).

Table 1. Occupational destination at six months by gender and qualification type

	Computer Science		Engineering	
	Male	Female	Male	Female
Manager & senior officials	10.3%	9%	10.5%	9.1%
Professional:	37%	27.6%	47.2%	36.8%
- ICT professional	30.5%	16%	4.7%	3.4%
- Engineering professional	1.4%	1%	37.8%	26.9%
Associate professional/technical:	22.5%	21.8%	15.8%	21.2%
- IT service delivery occupations	11.3%	6.5%	2%	1.1%
Administrative & secretarial	11.8%	26.3%	7.5%	14.4%
Skilled trades	1.9%	0.1%	3.2%	1.1%
Personal service	0.6%	2.5%	0.9%	2.2%
Sales & customer service	10.3%	10.8%	6.9%	10.6%
Processes, plant, & machine	0.9%	0.2%	2.0%	0.7%
Elementary	4%	1%	5.4%	3.4%
Total number of students	**6,685**	**1,990**	**6,850**	**1,315**

Source: based on original analysis of data supplied by Higher Educational Statistical Agency, Destinations of Leavers from Higher Education, 2002/03[2] (HESA, 2004)[3]; David Perfect, Equal Opportunities Commission, 2005

Summary of Findings

Although it is widely acknowledged that the IT sector is more graduate-rich than many others, especially at its senior levels, and that employers tend to prefer students graduating in related degrees (e-skills, 2003; Millar & Jagger, 2001; Miller et al., 2004), it would nevertheless seem that many women with directly relevant degrees fail to move into professional-level IT work; they do so at about half the rate that men do. Furthermore, women with degrees from unrelated disciplines are not faring better in relation to securing professional-level IT work—they also lag well behind their male counterparts in managing this transition (HESA, 2004; see also Computer Weekly, 2003).

In some respects, the picture painted in the previous analysis reflects the position of women across all occupational sectors, and within science, engineering, and technology occupations especially (Peters et al., 2003). Generally speaking, women in the UK tend, on average, to hold better educational qualifications than their male counterparts (EOC, 2004), but be employed in less prestigious and less well remunerated roles and occupations (EOC, 2004), so the rate at which these higher qualifications are converted into professional-level jobs is poor as compared to the conversion rate for men. These tendencies are often amplified when women select to work in gender-atypical sectors. As we have seen, however, there are elements to the story of women's advancement into IT that indicate that it is performing less progressively than some of the more traditional male dominated sectors that the industry was initially predicted to supersede in terms of its gender regime.

IT's Comparative Failure to Recruit Qualified Women: The Limits of the Self-Selection Thesis

The tendency for women to self-select out of IT work may still form part of the explanation of the picture as it is painted here, despite the fact that the women focused on have seemingly demonstrated their commitment to the IT area by opting for, and persisting with, a degree qualification in computer science. Such women still have the duration of their degree courses to be put off from working within the area, and there is evidence that this happens (Margolis & Fisher, 2002; Peters et al., 2003). Relying on the self-selection thesis as a mode of explanation is helpful only to a point here, however, unless we are to accept that the image of IT work and the educational experience of undertaking an IT degree, are *more* off-putting to women than the image and educational experience of engineering, and there is no evidence for this assumption.

The fact that women with computer science degrees do not manage to convert their qualifications to professional-level IT work at the same rate as their male counterparts points to there also being substantial issues in relation to the selection of women on the part of employers, and to the fact that women, consequently, 'encounter significant barriers when they attempt to pursue a professional career' in the sector (Millar & Jagger, 2001, p. A-7). These issues would seem to be independent of the quality and commitment of female applicants. Indeed, given the sometimes problematic experiences women often report having on their computer science degree courses, coupled with the fact that they are still more likely than men to achieve a "good" degree in the subject, it does not seem unreasonable to assume that those who attempt to convert their degrees into professional-level jobs in IT are exceptionally motivated and focused.

One key problem on the recruitment side is the fact that movement into IT work is still often based upon informal contacts and networks, especially in the context of the field's serial contract culture (Clarke, Beck, & Michielsens, 2002; Flood, 2005). Indeed, Roger Ellis, chairman of the UK's IT Directors' Network, has been recently quoted as saying, "professional networking ... is essential ... You can always answer advertisements, but there might be 300 applicants or more. Most senior IT professionals get their jobs through networks" (Flood, 2005). The claim has also been made in terms of promotion (Clarke et al., 2005), and is concerning in both respects because of research evidence suggesting that the more informal the recruitment process, the more likely it is that the stereotype of an ideal candidate for a job in IT will act as the default template guiding the selection process.

It is suggested that this stereotype reflects the existing composition of the occupational area, as well as elements within the culture's self-image, and operates to produce a "hidden" job specification list: male, white, graduate, with no discernible domestic commitments etc. (Clarke et al., 2002; Faulkner, 2002; Massey, Quintas, & Wield, 1992; Millar & Jagger, 2001; Woodfield, 2000). Evidence suggests that, whilst this profile will remain influential even within formal processes, in the context of informal ones, it can operate far more powerfully and is more likely to do so unchecked. With less formality, individual rapport, often based on personal identification with candidates, coupled with an "I'll know it when I see it" criteria, can more easily supersede the impact of formal qualifications, recommendations, job specifications and appraisals (Woodfield, 2000, 2002).

It is unsurprising, then, that the limited evidence of good levels of job satisfaction (CEL, 2005) amongst professional female IT workers, is more than eclipsed by that which consistently confirms the experience of women feeling like the "odd girl out" (Trauth, 2002). Professional women within the field, and across a diverse range of roles and life-cycle stages, report feeling that they fail to fit the default "ideal" worker profile well enough to experience, or progress within, the occupation as well as men (Computer Weekly, 2003; Faulkner, 2002; Grey & Healy, 2004; Millar & Jagger, 2001).

FUTURE TRENDS

There is increasing recognition that IT's culture, in privileging men over women, as well as failing to provide genuine equality of opportunity for female workers, may also be jeopardising businesses and short-changing the UK's economy (e-skills, 2004; Peters et al., 2003). There is very little evidence, however, that the sector will respond rapidly or effectively to pressures to develop more genuinely open recruitment and promotion policies and practices, either on the basis of business or equity principles (Clarke et al., 2002). This is all the more surprising given its chequered history of skill crises and personnel shortages. Macro-level equality initiatives generated by governments and agencies, and designed to persuade more women and girls to consider IT as a career option and more employers to select them, have been unevenly adopted on the latter's part (Clarke et al., 2002). The field remains more resistant than we might expect to family-friendly policies such as flexible working, return-to-work schemes, and a more general cultural shift towards addressing work/life balance issues (Faulkner, 2002; Grey & Healey, 2004; Millar & Jagger, 2001).

This is also surprising in the context of the initial, and, in some ways, persistent association of IT with the future, even, as the introduction here has indicated, with a less gendered future. IT's highly educated workforce, not unreasonably, can be taken as a superficial indicator of tolerance and broadmindedness. As well as being externally generated, these image elements are actively reproduced within occupational IT cultures, alongside legacy elements from its hobbyist and creative past that signify its workforce as edgy, cynical and creative individualists, too interested in the work itself to be distracted into irrelevancies such as office politics, too excited by, and admiring of, another person's skill to notice their gender or ethnicity (Meiskins & Whalley, 2002; Woodfield 2000). Although in some respects offering a welcome counter to the male, geeky and boring image the sector perennially endures, there is evidence that these more positive aspects of its image can operate discursively within the culture of IT to obscure structural inequalities based on gender differences, and then mute discussions of their implications (Woodfield, 2000). As Faulkner has suggested, the barriers to women within UK "may be the more tenacious precisely because they are not so immediately obvious" (Faulkner, 2002).

CONCLUSION

We need to take note of the demand-side factors when addressing the reasons for the pattern of female progress into IT, as much as those related to the supply of "willing" female applicants. Indeed, the female propensity to select out of IT work, even once within the industry, has also to be understood in this context, rather than analysed as if it were more an independent trait indicative of proactive "feminine" preferences than a reaction to perceived inequalities.

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KEY TERMS

British Computer Society: The industry body for IT professionals. (http://www.bcs.org/bcs)

E-Skills UK: e-skills UK is a not-for-profit, employer-led organisation, licensed by government as the Sector Skills Council for IT.

Equal Opportunities Commission: The Equal Opportunities Commission is an independent, non-departmental public body, funded primarily by the government. It provides free research reports and statistics chronicling the position of women and men in all aspects of UK life. (http://www.eoc.org.uk)

"Good Degree": A term used in academic literature and common parlance to indicate a UK degree which has been classified as a "Upper Second" or "First," (i.e., in the top two degree classifications). It is normally assumed that those going on to postgraduate study will have such a degree, and they are preferred in many employment contexts.

Higher Educational Statistics Agency (HESA): HESA was set up in 1993 by the UK Government to act as a central source for higher education statistics and has become a respected point of reference. (http://www.hesa.ac.uk)

IT/Computer Professional: An individual working within the UK IT/Computer sector within a complex and skilled role that is classified within the category "Professional occupations" (e.g., software engineers), or sometimes within "Associate professional and technical occupations" (e.g., computer programmers)—in the National Statistics classifications, Standard Occupational Classification Codes (2004). (http://www.statistics.gov.uk)

ENDNOTES

[1] Defined according to Higher Educational Statistics Agency categories as including: com-

puter science, information systems, software engineering, artificial intelligence, and other programmes within computer science.

2 These data are based upon an 80% response rate from graduating students and their institutions and are therefore not comparable to other HESA data. It is noteworthy, for instance, that more females than males responded here, giving the impression that female computer scientists comprise a third of all graduates in that subject area.

3 Percentages have been stated to the first decimal point, and there are very small numbers of "unknowns" within each column (under 1%)—columns may therefore not total 100%.

4 Also of note is the fact that men within engineering are similarly more likely to make this conversion than men within computer science.

Women and Social Capital Networks in the IT Workforce

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INTRODUCTION

Currently, the IT industry is experiencing explosive growth. As the need for more skilled IT workers increases, the focus on the diversity of individuals participating in IT jobs is highlighted. The under represented populations of women and minorities are being evaluated to determine ways to increase their lasting participation in the technology workforce. Although initiatives and programs have been established to recruit a more diverse labor force, the under representation persists. In an effort to address the problem of under represented populations in the IT workforce, it is necessary to evaluate the situation from a variety of angles and views. Specifically, we seek to better understand the "gender gap" in the IT workforce and the effect of social capital networks in the organization on women.

Social capital can be defined as "an instantiated informal norm that promotes cooperation between two or more individuals" (Fukuyama, 1999, p. 1). Social capital among workers in the organization has been attributed to career success due to increased access to information, resources, and sponsorship (Seibert, Kraimer, & Liden, 2001). One of the ways that social capital can be gained is through participation in networks. Overall, the benefits or advantages gained through the networking process are attributed to an increase in access to and sharing of information.

In this article, we consider social capital networks in the IT workforce and whether the existence of these networks assists in explaining the under representation of women in IT. Our research highlights the experiences of women practitioners and academics currently working in the IT field. Our aim is to uncover the story behind the organizational chart. In doing so, we summarize a study on women's participation with social networks in the IT workforce presented in Morgan, Quesenberry, and Trauth (2004).

BACKGROUND

The notion of an informal social network in the workplace is not a new concept. References have been made to the notion of an "Old Boy's Club," in regard to a network of men in a position of power and privilege in an organization who share resources and information to gain advantage and opportunities. This is particularly germane to the IT field since it is characterized as a male dominated industry.

In this situation, if an "Old Boy's Network" exists, then "women's informal isolation [could] result in men's greater influence and centrality" in networks (Moore, 1988, p. 575). So, the study of informal networks becomes even more important within this context (Morgan et al., 2004). The role of social networks may be playing a critical role in the exclusion of women from opportunities in the field. Social or informal networks have been defined as "the web of relationships that people use to exchange resources and services" (McGuire, 2000, p. 1). Research has pointed to the importance of social networks in areas such as status and power in organizations. Additionally, social networks have been linked to gains in skills, job leads, and mobility in an organization. A popular phrase correlated with social networks is that "it is not what you know, *it is who you know.*"

Social capital, which is gained in these networks, is defined as a virtuous circle of trust, including group membership and informal social ties (Putnam, 1993). The level of trust associated with social capital is critical to access to information. Social capital has a direct relationship to the amount and quality of the information that an individual is privy to. So, it can be inferred that the more social capital one possesses the more advantage they possess in relation to opportunity and resources in the organization.

By the same token, the lack of social capital and access to resources and information may result in a decrease in upward mobility, turnover, and career satisfaction. These factors can be detrimental to maintaining employees and specifically a diverse workforce.

MAIN THRUST OF THE ARTICLE

The literature concerned with social networks highlights the importance of informal and interpersonal relationships with others in an organizational setting. The practice of social networking has been investigated in several industry environments similar to the IT industry. Social networks are often described in terms of strong or weak ties. Strong ties are close personal relationships that are similar in nature to interactions that an individual would carry out with their family or friends. Weak ties reflect more superficial relationships in an organization that a person may have with a co-worker or colleague. The literature on social networks in organizations explains the benefits of them in terms of mentoring, acquisition of information, and sharing of information.

The importance of interpersonal ties in a social network was discussed by Granovetter (1973). According to the author, the "strength of an interpersonal tie" is determined from a "combination of the amount of time, the emotional intensity, the intimacy, and the reciprocal services which characterize each tie" (p. 1361). The importance of "weak ties" highlights an opportunity for community acceptance. This takes place due to ties that extend out of an individual's primary social network that connect him or her to other important social networks. These additional social networks are often valuable information resources. Granovetter showed that weak ties were often the source of job opportunities for the subjects in his study. Lin, Ensel, and Vaughn (1981) discuss the effect of networks in the process of job seeking. This research suggests that a job seeker's ability to reach a job contact with high-status is influenced by their personal resources and use of their weak ties. It has also been argued by Wegener (1991) that social networks are beneficial to subgroups of job seekers in a variety of ways. The study explains that individuals with previous experience in high status jobs benefit from weak ties, while those from low status jobs do not. According to Brass (1985) being connected informally to the management and supervisors of an organization affects a person's influence in that organization. Those in high-level decision making positions in an organization are deemed as the "dominant coalition" (p. 329). Traditionally, men have occupied these positions, something that has increased the difficulty for women to be a part of informal interactions with people in power in an organization. Mentoring is also an important process that occurs in an organization which is affected by the presence of social networks.

The process of mentoring and its effect on women is discussed by Burke and McKeen (1990). The authors point out that a potential hindrance to women participating in cross gender mentor relationships may be due to their inability to access information networks. This circumstance is the tendency to develop relationships with people with similar characteristics, or male management excluding women. Eby (1997) discusses the benefits of the mentoring process in the organization. Mentoring is described as a medium through which individuals gain specialized knowledge and skills, which then provide people an increased ability to adapt to change in an organization. Participation in traditional mentoring increases the likelihood for an individual to develop peer networks. Peer networks, then, may also result in peer mentoring which is an additional point of leverage for the protégé. The expansion of the peer network increases an individual's opportunity to access resources and information regarding skill sets, career prospects, and strategies. The process of information acquisition is another important process which occurs through formal communication and through social networks.

The notion that a large informal network supports a person's mobility in an organization through the acquisition of resources and information is discussed by Podolny and Baron (1997). The absence of "structural holes" in an individual's network with management and others in the organization with "fate control" increases this mobility. People in an organization with "fate control" have some critical investment in the success and direction of the organization. The types of information that flow through a social network are described as task advice, strategic information, buy-in, and social support. Siebert et al. (2001) provide a framework which details the importance of social capital on career success. It was shown that a person's social network was influenced by access to information, access to resources, and career sponsorship which all may have an impact on career success. In addition, information sharing is an important process which can be made even more beneficial through the use of social networks.

Research has shown that gender inequality in organizations can be reinforced by sex-related differences in social networks (Ibarra, 1992). Homophily was cited as a cause of this gender inequality. Homophily refers to the preference to create same-sex work relationships in networks. An additional factor which has proven problematic in joining social networks is in translating personal characteristics and resources into a means of advantage in a network situation. Mehra, Martin, and Brass (2001) detail how different actions can be enhanced or inhibited by interaction in social networks. The authors report that people in networks may experience a variety of outcomes as a result of the attribute of their network. Often, people who are able to bring together less familiar individuals with one another benefit from an increase in information, resources, mobility, and control. Those individuals who participate in smaller social networks generally do not benefit from the myriad of information that is achieved through participation with expansive networks. The next section will explain how women's participation in the IT workforce was evaluated to identify their relationships with social networks.

Methodology

The methodology guiding the study is based upon an NSF funded study on individual differences in the social shaping of gender and IT. This study is a qualitative research project which seeks to test an empirical theory that addresses the experience of women in IT. This article reports on interviews with women conducted between October 2002 and December 2003 with 44 female practitioners and academics working in the IT field in the United States. These in-depth interviews were held with women in Massachusetts, North Carolina, and Pennsylvania. The women were diverse in their demographic and personal characteristics. The interviews lasted approximately 90 minutes, and the interview items were derived from prior research into gender and IT (Trauth, 1995, 2002). The interviews were coded based on a coding scheme which is informed by the Individual Differences Theory of Gender and IT (Trauth, 2002; Trauth, Quesenberry, & Morgan, 2004). The data being collected reflects information about the participants' personal information, shaping and influencing factors, and environmental context. The theory which is guiding this research investigates the individual attributes, individual influences, and environmental influences of women in IT to determine how these factors influence their participation in IT. Additionally, the theory asserts that women will respond to and experience different socio-cultural elements that affect their participation in the IT workforce in an individual manner. The research reported in this article seeks to provide further evidence in support of individual differences among women working in the IT industry.

Results

Analysis of the women's accounts reveals that informal social networks assist in the flow of information through nontraditional channels in the organization. The type of information that is gained though these social networks can be categorized into four areas: career opportunities, task information, mentoring, and personal advantage.

Career Opportunities

Information regarding job openings, promotion, and opportunities for advancement are largely passed through social networks. In certain situations, network contacts can provide individual access to recruiters, managers, interviewers, or others in charge of hiring. For example, *Allison was offered a job she did not apply for because of network contacts*. In addition, the participation in a social network can provide exposure to decision makers who are in charge of career decisions. *Betty Jean discussed finding her permanent job through friendships gained by personal networking.*

Task Information

Task information that is gained through social networks regarding job specific activities assists in gaining important skills for advancement in the workplace. Often, the sharing of information can provide a way in which to resolve problems or situations, and achieve desired goals or results more quickly. *Julia discussed her experiences of bonding with men socially outside of the workplace, so when she needed help they were more than willing to help her*. In addition, assistance can be granted by other members of the social network who are outside an individual's immediate team members or colleagues. *Donna mentioned that the other developers would help her to understand the technical things she did not know.*

Mentoring

Some forms of mentoring are established at an organization level, but a great deal of personal mentoring goes on with other members of a social network or while participating in networking activities. The gain in knowledge and social capital can be tremendous if a person has both formal mentors, and informal ones as a result of social networks. For example, *Irene learned how to handle career situations though her mentors.*

Personal Advantage

Social capital networks also provide advantage by allowing a person to form a personal bond or level of trust with other members of the organization. This advantage can come from exchanging information about family, hobbies, or interests, as well as by participating in social events such as lunches, happy hours, golfing, or shopping. The bond formed by people in social networks can also lead to a greater appreciation and value of a person and their work. *Jeria discussed her male work environment where she made an effort to fit in with men and became their platonic friends. She discussed going out after work with her male colleagues.*

The analysis of our data also revealed that women participate with social networks in a variety of ways: in the network, outside the network, and in alternative networks.

In the Network

Those women who participate in the established social network in their organization may share some common bond of experience, interest, or likeness with other members of the network. Thus, the women's participation in the network may appear to require less effort and be more meaningful to them. *Joanne discussed her male work environment where she worked to fit in with men and became their platonic friend. She discussed playing video games with her male colleagues.* Among the women who did not share similarities with members of the network, some decided to develop interests in common with those involved in the network. For example, *Sharon took flying lessons to be able to join in lunch conversations with her male colleagues.* These women proactively made a decision to establish a bridge into the network to gain acceptance from the members. It appears that in this type of situation, there is some element of choice which is provided to the women regarding whether or not they are able participate and interact with the members.

Outside the Network

Being outside the network may be based on the group discriminating with respect to admission. The members of this social network may not be open to including individuals who do not share the commonality that links them together. Often, the sole criterion for membership in this group is gender. *Jeanette described her boss who had two guys who acted as his henchmen and who established an inner circle where everybody else was excluded.* When one is outside of the network and excluded, the members of the group often deny these contributions. *Claire explained that she was an experienced programmer who was given clerical work on her project due to her gender and her nonmembership in the network.* In addition, due to some other personal responsibilities, such as family duties, many women appear at times to choose not to participate with the network or their activities. *Carol explained that guys would stay at work overnight and come in on weekends, she did not feel that was an option for her because of her responsibility to her family.*

Alternative Networks

The alternative network is a new network. The women who have chosen this option have experienced elements of either a closed or open network, but have nevertheless chosen to develop or participate in a network better suited to them. These women appear to see the value in networking and are motivated to interact with and create other network opportunities. Some alternative networks may be based outside of the workplace, but provide networking opportunities nonetheless. *Emily described being involved with a support group for "design" Web women outside of the workplace.*

The analysis of women's experiences has shown that they respond in a variety of ways to inclusion and exclusion from the network. The women in this study reacted to the situation through a mechanism of their environment, personality, and responsibilities. The interaction with these social networks will continue to be an important area of research with respect to women's participation with technology.

FUTURE TRENDS

A recent study conducted by Forret and Dougherty (2004) found that "the relationship between engaging in professional activities and total compensation for females was negative, while for males the relationship was positive" and that "increasing internal visibility was significantly related to number of promotions and total compensation for men, but not for women" (p. 429). These findings are important because it shows evidence that the professional advancement of women is not occurring in the same manner as it is for their male counterparts. So while networking behavior has been deemed critical to career success, there are still factors which prevent the contribution of women from being realized at their full capacity. Future research into this area should not only investigate the women in different workplaces, but also the policies, processes, and initiatives that actively or subtly facilitate gender inequality in organizations.

CONCLUSION

This article has examined the presence of social networks in the IT workforce and the subsequent effect on women in the field. The analysis of our data has revealed, through the lens of the Individual Differences Theory of Gender and IT, evidence that this informal network does indeed affect how women interact with others on a daily basis in the IT workforce. Good networking skill is essential for success in most industries, but when obstacles prevent the prospect of networking, a challenging situation becomes even more difficult. The women in this study provided some insight into their strategies and coping mechanisms utilized for continued participation in the workplace. Some women are in opposition to an artificial interaction with people with whom they do not share common interests, while others choose to neglect their own personal interests in order to fit in. Through these responses, women are expressing how they cope with an organizational phenomenon that has no sign of dissipating in the near future.

It is important to point out that a position inside or outside of the network is a dynamic factor. Very possibly, over time, a woman may move among social networking as her career and environment evolve. The contribution of this article is to provide further insight into the gender gap in the IT workforce by addressing a potential barrier to the participation of women. Further research in this area may evaluate the effect of the positioning with regard to networks and how that impacts overall career satisfaction and success.

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KEY TERMS

Individual Differences Theory of Gender and IT: A social theory developed by Trauth et al. (2004) that focuses on within-group rather than between-group differences to explain differences in male and female relationships with information technology and IT careers. This theory posits that the under representation of women in IT can best be explained by considering individual characteristics and individual influences that result in individual and varied responses to generalized environmental influences on women.

"Old Boy's Club": An informal network in which men are able to share information in a less formal setting, learn to trust each other, and establish personal relationships which generally provide advantage to those who participate in it.

Social Capital: An instantiated informal norm that promotes cooperation between two or more people.

Social Networks: The web of relationships that people use to exchange resources and services.

Women and the IT Workplace in North West England

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INTRODUCTION

The United Kingdom (UK) information technology (IT) industry is highly male dominated, and women are reported to account for an estimated 15% of the sector's workforce (EOC, 2004). In Spring 2003 it was estimated that there were 151,000 women working in IT occupations compared to 834,000 men (EOC, 2004) Additionally, it has been reported that these numbers are rapidly declining, as women are haemorrhaging from the industry in disproportionate numbers (George, 2003). Although they are making inroads into senior and technical roles, "vertical segregation" is observable. Overall, women tend to be represented in lower-level IT jobs, with the majority, 30%, in operator and clerical roles; and the minority in technical and managerial roles, 15% of ICT management and 11% of IT strategy and planning professionals (EOC, 2004). This renders a "feminisation" of lower-level IT occupations. Educational statistics have also shown that fewer women are enrolling onto computer-related courses; there was a drop from 24% in 2000 to 20% in 2003 (E-Skills, 2004a)

BACKGROUND

Women's exclusion from technology has been attributed to the historical and socio-cultural construction of technology as a "masculine domain" due to the relationship between masculinity and technological skills, rejecting claims that technology is "neutral" (Wajcman, 1991; Woodfield, 2000). Further, Cockburn (1985) argues that power differences between the sexes and their relationship with technology were consolidated in the development of capitalism and the move to manufacturing production. Working-class tradesmen formed into trade unions, which sought to exclude women, therefore denying them access to gain necessary skills to exploit in the labor market.

Wajcman (1991) suggests that "skill" is not some objectively identifiable quality, but rather, is an ideological category, one over which women were and continue to be denied the rights of contestation. Notions of "masculine" and "feminine" skills are problematic in the workplace, as there is more emphasis on the nature of the worker rather than the work. Additionally, categorisations and equations relating to skill are deeply ingrained with sexual bias; for example, men/skilled, women/unskilled (Woodfield, 2000), and further distinctions such as dirty/clean, heavy/light and technical/non-technical, which Game and Pringle (1984) argue have been constructed to preserve the sexual division of labor. Therefore, technological skill has historically been defined as "exclusively male," whereas women's traditional work, such as nursing, is defined as non-technical (Cockburn, 1985). Additionally, as this type of work has been socially constructed as un-skilled and un-technical, it has also been undervalued; consequently, work of women is often deemed as inferior just because "it's work women do" (Wajcman, 1991). Furthermore, this perception has led to the "gender typing" of roles in the workplace.

Gender divisions are actively created and sustained in organisational and domestic life. IT organisational culture is one embedded in a sociopolitical context of gender discrimination and the masculine domain of technology. If it is credible that (technical) skill and masculinity are so intimately entwined, then it is hardly surprising that women who challenge these masculine skills by gaining them themselves are subject to working under female unfriendly conditions and in hostile environments. It is also not surprising, then, that women must develop a number of coping strategies to deal with these sometimes impossible situations.

THE WINWIT STUDY

The purpose of this article is to present evidence of the working conditions and the cultural barriers women experience when working in the North West IT workplace. The Women in North West IT (WINWIT) project funded by the European Social Fund (ESF) was established to investigate the current regional situation for women in the IT labour market. The study was conducted over a 12-month period (January 2004-December 2004) by researchers at the University of Salford's 6* RAE Information Systems Institute. The aim of the research project was to determine reasons for the under-representation of technical and senior women from public and private North West IT organisations and departments. The study explored issues for women entering, progressing, leaving and returning to the industry, as no specific data was previously available at the regional level. The researchers conducted 11 in-depth interviews with a heterogeneous sample of women at various stages of their careers and hosted an online questionnaire via a project Web site (www.isi.salford.ac.uk/gris/winwit). These women were selected from a variety of sources and were highly technical, with various levels of managerial status. The women were chosen for interview on the basis that they were interested in contributing to encouraging other women into or back to the industry and to support those already participating. The qualitative data was central to the study, as this provided valuable views and experiences from the labor market sample. The researchers developed trusting relationships with the interviewees to alleviate worries and reluctance to participate. Interviews were conducted in a relaxed neutral setting, away from the workplace. A critical approach was taken when analysing the interview data to gain greater understanding of the under-representation of women in the sector. The main themes to arise from the investigation are barriers to work-life balance, organisational culture, pay and problematic equal opportunities and diversity policies.

Working Conditions in IT

The following section will examine the working conditions in IT and offer examples from the WINWIT study. In the UK, current Equal Opportunities legislation makes it acceptable to offer work only on a full-time basis even though this is difficult for many women to take up (Liff, 1997), particularly in the IT sector, as work is typically full-time, with only 5.3% (Platman & Taylor, 2004) of the total workforce working part-time. A long-hours culture is ubiquitous in today's British companies, where UK employees work some of the highest hours in Europe—more than 48 per week (Rutherford, 2001), often involving unpaid overtime. These practices were reported as problematic for women from both public- and private-sector IT organisations, who gave accounts of long hours being used as a bargaining tool by women with families in return for four-day work weeks and reports of working 50 hours plus; these type of working conditions are indicative of the "hacker culture." Males and females experience conflict between work and family lives differently, with women exhausted trying to maintain domestic and professional roles; conversely, men regret that they couldn't spend more time with their children (Liff, 2001).

The flexibility required by clients often means constant availability (Hoque & Noon, 2004), particularly for those in technical and managerial roles. This can involve time spent away from home, sometimes for long periods. An interviewee explained how she often worked long hours and away from home: "I know I am single and don't have a family to take care of, but I still have priorities and don't just want home to be somewhere I dump my bags at weekends." Further, she commented that this was something that had to be done to get on and the fact that not everyone was in the situation to do this was secondary to the organisation. Other women that did not have children had contemplated that they would have to change careers or leave the industry if they ever did start a family. Those women (10 out of the 11) who were aware of "flexible working practices" within their organisation described how attitudes of resentment were evident as comments were made relating to "unfair policies," as part-time and home working were only offered to women with caring responsibilities. Flexible working models severely limit women's progression opportunities, as employers assume it shows a lack of commitment to their career (Guffens et al., 2004).

Individualized approaches are primarily understood as a way of reducing the influence of traditional industrial relations with Human Resource Management (HRM) policies focusing on individualized pay packages, contracts and development needs (Guffens et al., 2004). Women told how this approach was problematic, as being expected to vie for projects requires a degree of self-advocacy, and the ability to negotiate contracts and pay packages requires a high level of confidence and excellent negotiation skills. Of the 11 women interviewed, 10 conveyed that these were "not natural characteristics"; however, they were aware that this was something "men are good at." A culture of "salary secrets" and pay discrimination was evident from the sample women; figures of up to £17,000 a year were indicated as the difference women experienced compared with that of their male colleagues. Some of the key factors attributed to the gap were said to be returning to work after having a baby and choosing a work-life balance, a lack of confidence to push for higher salaries and informal pay structures. Although some felt that this wasn't deliberate discrimination by their employers, putting it down to "it's just the road women end upon historically" and "its just the way things are," others, however, did express extreme anger.

Where clients require constant availability, working long hours and blatant pay discrimination, it is no wonder that women working in the North West IT sector reported difficulties with confidence, often framing the problem in individualistic terms rather than a structural feature of the IT workplace. "Gender blind" organisations that encourage these working practices undermine equality policies, further excluding women (and men) from the technical sphere.

IT a "Fitting" Place for a Woman?

Questions were asked about the working environments and how comfortable women felt with a male-dominated culture. The following points were raised: Five out of the 11 interviewees started their career in a purely technical role and had transcended to a hybrid (technical and interpersonal) role due to the "maleness" of the workplace. The working environment was described in terms of "hostile,"and experiencing "isolation" and "exclusion." One woman explained how she was reduced to feelings of regret with her choice of career because she was so unhappy and lonely working in an all-male environment. Another used the word "painful" when describing her experience of being the only woman out of 80 people in an IT department.

Amplification of the masculine culture is often demonstrated through male camaraderie and perpetuated by sexual discussions and crude humour (Simpson, 2000). One participant described how she perceived that it was a prerequisite to have grown up with lots of brothers if you wanted a career in the IT industry and commented that you have to fit in with the majority of men and not be upset by the banter, adding, "sensitive types wouldn't last 2 minutes." Men were reported to group together in and out of work, forming after-work pub cultures, which for some women was neither desirable nor, in some cases for those with commitments, accessible. Informal networking and leisure pursuits were often male oriented—reported options were mountain biking, go carting and football. Some women expressed anxiety about being excluded from informal networks, as they felt it was imperative for career advancement to be seen. Two participants explained how the centricity of their organizations made it difficult to network, as all the senior managers were in the South of England, one referred to being "out of sight out of mind" and both were aware that had they been able to liaise and socialize with senior managers, their careers would have advanced sooner.

Displays of femininity in the IT workplace were problematic for women; one respondent who was the only women in charge of a group of 15 men didn't want to stand out as a female and felt that high visibility would make it difficult for her to "fit in," be accepted and taken seriously as a manager. In a bid to mask her femininity, she took to wearing gender-neutral clothes, "chinos" and a "polo shirt," and described herself as a genderless "it," only gaining confidence to revert back to feminine attire once she was completely satisfied she had proved herself professionally.

All interviewees expressed high levels of satisfaction, particularly regarding the opportunity to combine technical and communication skills; however, often, highly skilled women played down their technical knowledge when talking about their work in general terms. I'm not in IT but … "I'm in the people part of the organization," "I'm a manager" and "I'm in sales." As our data reveal, women struggle to get comfortable in technical environments. Women's estrangement from purely technical roles and identifying oneself as having hybrid technical-people skills presents a very positive coping strategy for many women. However, this vehement rejection of any identification with technology does not bode well for future "women into IT" initiatives, and indicates a major cultural barrier that needs to be confronted.

FUTURE TRENDS

The UK has the highest employment rate in the world (Stanfield, Campbell, & Giles, 2004) although this source of labor is declining as the population is aging; individuals more than 60 years old now form a larger part of the population than those younger than 16. The Office for National Statistics (ONS, 2004) predict that by the year 2012 there will be 1.3 million new vacancies in the economy and the vast majority of these will be taken by women. However, 80% of the current workforce will still be employed in the labour force in 2010 (Stanfield et al., 2004). Platman and Taylor (2004) indicate there is a "fundamental cultural problem" with the way the IT sector approaches recruitment and employment; the market is failing to employ the younger generation, to retain sufficient numbers of women and to take advantage of the aging workforce. In addition, part-time and flexible working is rare, and is a reason women and older people are leaving the sector. Labor market intelligence (E-Skills, 2004b) envisage the need for advanced and high-level skills in particular to increase, and a vital need to adequately anticipate skill demand, as many IT professionals require years of training.

Given that women make up an essential element of this personnel and the current acute under-representation of women in IT jobs (George, 2003), women in the IT industry are facing real difficulties working in male environments where long hours are the norm, UK men work the longest hours in Europe and cultures exist where employers reward those who give their time entirely to work. Additionally, women are experiencing added strain from client demands, peer pressure and the tension of having to work harder and longer, coupled with difficulties of negotiating "individual" flexible working conditions, resulting in poor employment conditions that cannot be improved while this norm dominates. Consequently, a substantial proportion of women who wish to work part time or have primary caring responsibilities results in a section of the workforce being excluded, neglected, not encouraged to enter or forced to leave the industry.

Breaking through the glass ceiling (2003) states work-life policies cannot be seen as a perk; attention needs to be focused on the "sticky floor" phenomenon as much as if not more so than the "glass ceiling" syndrome. It is employees predominantly at the lower levels of organisations who experience the least amount of control over their work and time and have less access to work-life policies (Wise, 2003).

However, according to Brandth and Kvande (2001), businesses implementing new working practices without designing or generating new job specifications are unlikely to achieve the best outcome for individuals or businesses. Questioning rigid and unsuccessful working practices in conjunction with the way work is allocated, organised and rewarded has to be fundamentally challenged, as concerns are unlikely to be resolved until men's work-life issues are explored and understood, the results of which ought to produce a more equal share of paid work and caring responsibility between the sexes (Brannen, Lewis, Nilsen, & Smithson, 1997).

CONCLUSION

The points raised by the WINWIT sample were neither surprising nor original, yet they provide a unique view of women's experiences of working in the North West IT industry and provide a sound basis for future study. Challenging women's under-representation in the IT sector is problematic, as this article clearly shows that technology is considered to be a "masculine domain." Despite years of equal opportunities and related policies, many obstacles still remain for women working in the IT sector, chiefly the insidious and embedded organisational culture that maintains workplace discrimination through institutional processes and prevents women from entering male-dominated, higher-paid and higher-status occupations. Women's under-representation in the IT industry should not be looked upon as a "women's problem," but rather a problem for the industry as a whole. But organizational change is not a simple, single process that can come about immediately, as Steel (2000) states: "change is very fragile and can easily be destroyed." Once genuine change seems likely, the organisations' members will attempt to resist new ideas and practices, thus the need to encourage and nurture new behaviours will prove problematic.

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KEY TERMS

Feminisation: Where the rise in female labour force participation has been driven largely by an increase in the demand for female labour, pulling women into the labor market.

Flexible Work Practice: Alternative work arrangements for people whose life circumstances make standard employment practices of 9 a.m. to 5 p.m. restrictive and not the best option. Flexible work practices include various types of work arrangements, such as part-time work, job sharing, working from home, flexi-time and term-time working.

Gender: The term gender refers to culturally based expectations of the roles and behaviours of men and women. Sex identifies the biological difference between men and women. Gender identifies the social relations between men and women. It therefore refers not to men and women, but to the relationship between them and the way this is socially constructed.

Gender Blindness: Gender blindness refers to a failure to identify or acknowledge difference on the basis of gender where it is significant. It can be a person, policy or institution that does not recognize that gender is an essential determinant of the life choices available to us in society.

Gender Typing: The process through which occupations come to be seen as appropriate for workers with masculine or feminine characteristics.

Salary Secrets: The hidden truth regarding pay inequality between men and women often being allowed to go unnoticed until women reach senior management levels.

Vertical Segregation: Concentrating individuals in the lower echelons of an organisation. (Term taken from Occupational Segregation (EOC).

Women Embrace Computing in Mauritius

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INTRODUCTION

Studies like Camp (1997), Gurer and Camp (2002), Sigurdardóttir (2000), and Vegso (2005) have documented the declining percentage of women in computer science (CS) in the United States and other countries. While women are underrepresented in the United States overall, there are cultural pockets within the country that are exceptions to the rule. For example, Lopez and Shultze (2002) note that African-American women earned the majority of CS bachelor's degrees each year from 1989 through 1997 at historically black U.S. colleges and universities. Fisher and Margolis (2002) and Frieze and Blum (2002) report some success in increasing the percentage of women studying computing at Carnegie-Mellon. Camp, Miller, and Davies (2001) point out that the problem is significantly worse for CS departments housed in a school of engineering compared to those housed in a school of arts and sciences, a phenomenon dubbed "the school of engineering effect." So while women are on average underrepresented in CS in the United States, such national averages can hide significant variance within a country's subcultures.

Outside the United States, Schinzel (1999) notes that the situation in Anglo-Saxon, Scandinavian, and German-speaking countries (ASGs) is similar to that in the United States, but female representation in CS is comparatively constant and high (45-50%) in Greece, Turkey, and the Romanic countries (e.g., France, Italy). Schinzel's data are fragmentary, but they offer intriguing hints that culture plays an important role in encouraging or discouraging women from studying CS.

These and reports like Galpin (2002) indicate that there are non-ASG countries where women are equally represented in CS. This in turn suggests that the problem is one of culture: ASG cultures apparently in some way discourage women from choosing IT-related careers, while the cultures of these other countries apparently encourage women to do so. If the root of the problem is the culture in the ASG countries, then that is where we should focus our efforts.

What is it about the culture of the United States and other ASG countries that discourages women from studying CS? Trying to analyze the negative cultural factors from within an ASG country is rather like a fish trying to analyze the water in which it is swimming. A preferable approach is to become a "fish out of water" and visit a non-ASG country where women are studying CS. By identifying those cultural differences in non-ASG countries that are leading women to study CS, we can identify those aspects of ASG culture that are problematic.

In this article, we examine the country of Mauritius, a 25x40-mile island roughly 500 miles east of Madagascar that is home to 1.2 million people. Ethnically, its population is 68% Indo-Mauritian, 27% Creole-African, 3% Sino-Mauritian, and 2% Franco-Mauritian. Religiously, its people are 52% Hindu, 28% Christian, 17% Muslim, and 3% other religions. With this dynamic mix of people, Mauritius is one of the world's most culturally diverse countries.

BACKGROUND

Prior to 2001, the University of Mauritius (UoM) was the sole university in Mauritius, offering bachelor's and some graduate degrees to roughly 4,000 students. The university is free, and admittance is based solely on standardized entrance-exam scores. With roughly 1.2 million people in Mauritius, admission is extremely competitive and the admitted students are highly capable.

Applicants to UoM indicate the program they wish to study, plus alternatives should their first choices be full. Beginning with the top-scoring students on the entrance exam, students are matched to programs using their first choices unless that program is filled, in which case they are matched to their alternative choices. Admission is thus based on merit, plus supply and demand for particular programs; UoM has no special admissions policy to increase underrepresented groups.

UoM's Department of Computer Science and Engineering (CSE) provides the country's primary source of computing-related education. CSE offers bachelor's degrees similar to those of a U.S. technical university, and has periodically updated its programs and curriculum to reflect technological changes. Since 1990, it has offered the following programs.

- **1990-1997:** Bachelor of Technology in CSE (BT-CSE)
- **1997-2000:** Bachelor of Engineering in CSE (BE-CSE)
- **2000-Present:** Bachelor of Science in CSE (BS-CSE)
- **2000-Present:** Bachelor of Science in Information Systems (BS-IS)
- **2001-Present:** Bachelor of Science in CS and Multimedia (BS-CSM)

The BS-CSE and BS-IS programs are very similar to computer-science and information-systems programs in the United States. The BS-CSM blends traditional CS training with training in graphical design and multimedia applications. While the BT-CSE and BE-CSE are 4-year programs, the BS-CSE, BS-IS, and BS-CSM are all 3-year "UK style" bachelor's programs.

GENDER IN MAURITIUS

In this section, we explore the representation of women in the CSE department at UoM. More precisely, we present data showing the rates at which female students enroll in and graduate from CSE programs. These data show that the gender and IT situation in Mauritius is quite different from ASG countries. In an attempt to explain these differences, we conclude this section with some aspects of Mauritian culture that, in our opinion, are responsible for these differences.

Students Entering CSE Programs at UoM

Figure 1 presents the number of students enrolling in CSE programs each year.

Figure 1. First-year CSE students by program

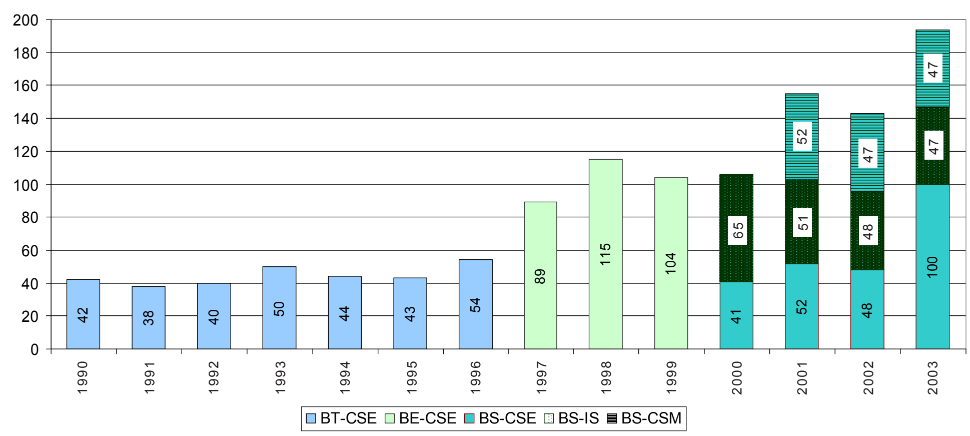


Figure 2. Percent of 1st-year CSE females by program

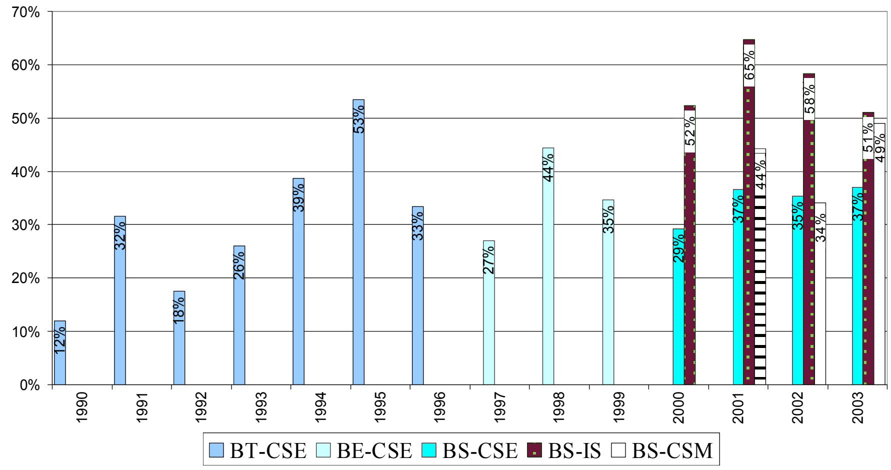


Figure 1 shows rapid increases in CSE enrollments since 1997. Each year, the department has admitted the maximum number of students for which it had staff.

Figure 2 gives the percentages of these students who were women by program.

While the data are noisy, Figure 2 shows increasing representation of women overall. By 2003, women were choosing to enroll in computing-related UoM programs at levels most of us in ASG countries can only dream about: 37% for CSE, 51% for IS, and 49% for CSM. It also indicates that Mauritian women are more attracted to the BS-IS and BS-CSM programs than to the BS-CSE program. One possible explanation is that the BS-CSE has high-school physics as an admissions prerequisite, but the BS-IS and BS-CSM do not, and Mauritian girls are less likely to have this prerequisite. Alternatively, it may be that simply having the word engineering in the name of the program is sufficient to discourage women, similar to the school-of-engineering effect noted in Camp et al. (2001).

Figure 3 presents the percentage of first-year CSE students who were women across all three of the department's programs.

The linear-regression trend line in Figure 3 shows that the percentage of women entering a CSE program at UoM has steadily increased from 12% to well over 40%, even as this percentage has declined in ASG countries.

Students Completing CSE Programs at UoM

Figures 1 through 3 indicate that increasing numbers of women are enrolling in computing-related programs at UoM. What about their graduation rates? Analogous to Figure 2, Figure 4 presents the percentage of female students graduating from each CSE program at UoM.

Aside from the short-lived BE-CSE program, Figure 4 shows the percentage of women graduating from CSE's programs increasing over both the long term and the short term.

Figure 3. Percent of 1st-year CSE females across all programs

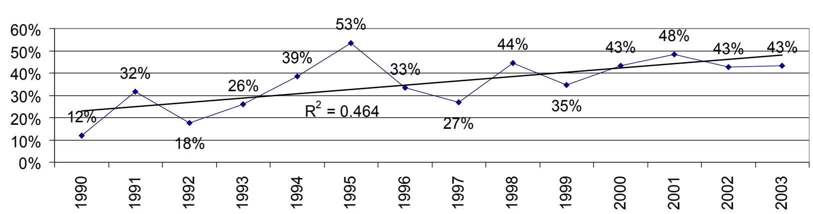


Figure 4. Percent of graduating CSE females by program

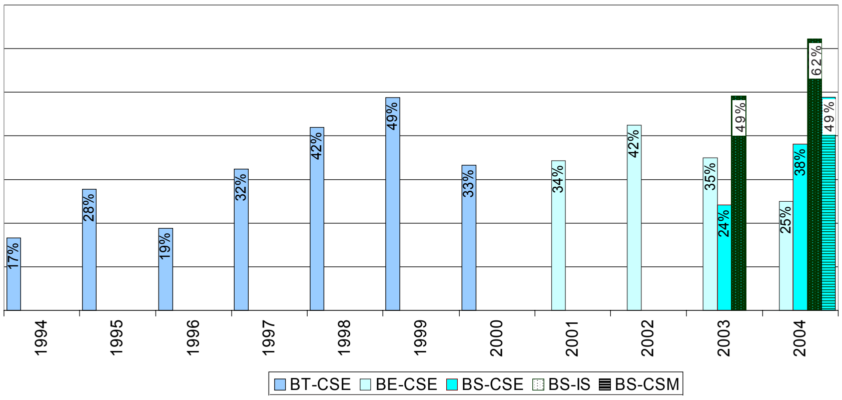


Figure 5. Percent of final-year CSE females across all programs

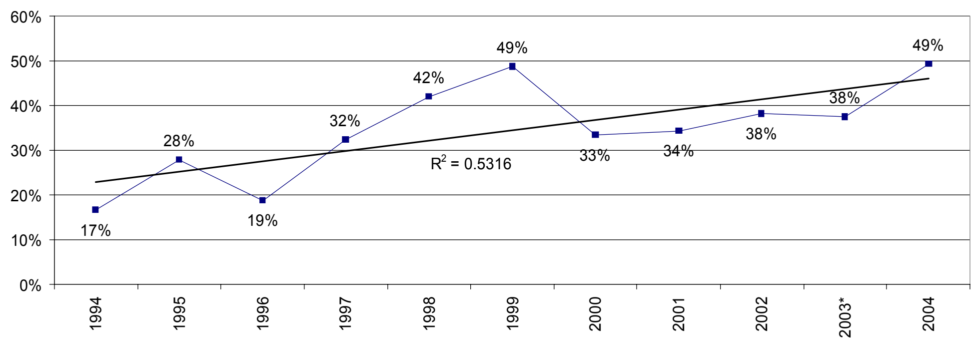


Figure 5 (analogous to Figure 3) presents the percentage of graduating students who were women across all of the CSE department's programs.

Once again, we see steady growth to levels approaching those of the population during the same period of declining representation in ASG countries. When coupled with the increased intake of first-year students shown in Figure 1, Figure 5 implies very rapid growth in the number of Mauritian women choosing a computing-related program.

Are Positive Role Models the Reason?

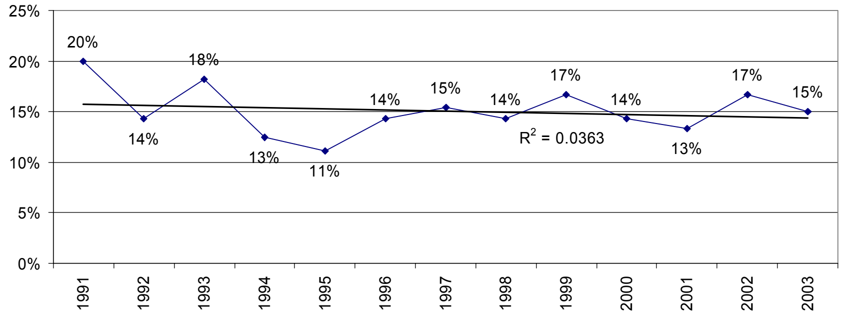
The increase in the representation of CSE women at UoM described above cannot be attributed to abundant female CSE instructors serving as positive role models or mentors. From 1990 to 2003, the female-to-male CSE instructor ratios were 0:7, 1:5, 1:7, 2:11, 1:8, 1:9, 2:14, 2:13, 2:14, 2:12, 2:14, 2:15, 3:18, and 3:20, respectively. Figure 6 shows the percentage of female CSE instructors during these years, omitting 1990 (when there were no female CSE instructors).

That is, the representation of women as a percentage of CSE instructors is low relative to the percentage of students who are women, and it has declined slightly as the total number of instructors has increased. During these years, the median percentage of female instructors was 14% (average is 15%).

There has also been significant instability in the set of female CSE instructors.

- In 1992, the sole female CSE instructor was a visitor from the United States; she was also one of the two instructors in 1993, after which she returned to the United States.
- In 1996, one of the female instructors was on leave.
- In 1997, both female instructors were on leave.
- In 1999, one female instructor was on maternity leave.

Figure 6. Percent of female CSE instructors



- In 2001, one female instructor was new, and the other was on leave without pay.
- In 2002, one female instructor was new, and another was on maternity leave.
- Under pressure to balance graduate work, family responsibilities, and teaching obligations, these female instructors had very heavy workloads.

This instability in the set of female instructors, coupled with their comparatively low percentage (Figure 6), indicates that abundant, positive female role models are not responsible for the increasing participation and retention of women in computing-related programs at UoM (Figures 3 and 5). While abundant and positive female role models are likely a good thing (for contrasting views, see Bettenger & Long, in press; Pearl, Pollock, Riskin, Thomas, Wolf, & Wu, 1990; Townsend, 2002), the data from Mauritius indicates that they are not a necessary condition for attracting young women to or retaining young women in computing-related programs.

Cultural Factors

We believe that cultural factors are why increasing numbers of women are studying computing in Mauritius. Table 1 lists few that seem especially relevant.

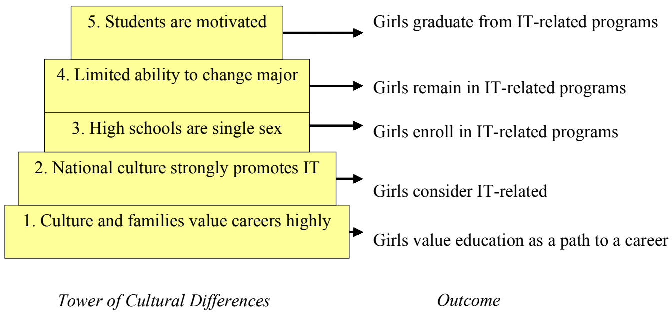
The most obvious difference is that Mauritius is a developing country, whereas most ASG countries are first-world countries. The needs and priorities in a developing country are necessarily different from those of the first world. That is, where a first-world country is maintaining its existing infrastructure, a developing country is building its infrastructure. The cultural imperatives of a developing country are thus different from those of a first-world country. For example, IT is seen in Mauritius as fresh, modern, challenging, and the path to rapid social advancement and national development. Negative words like “geek” and “nerd” are nonexistent in the Mauritian cultural vocabulary.

Relatedly, the Mauritian government is actively and visibly working to build its national IT infrastructure. In the late 1990s, the government began a national IT initiative to turn Mauritius into a “cyber-island” (Ackbarally, 2002). This initiative has further elevated the importance of computing and IT in the national consciousness, making them prestigious (and even patriotic) subjects to study. (The rapid post-1997 increases in CSE admissions visible in Figure 1 are one result of this initiative.)

Table 1. Some Mauritian and ASG cultural differences

Economic level (developing vs. first world)
Governmental promotion of IT
Family emphasis on the importance of education and career
Gender-separate but equal secondary-education system
Limited ability to change major programs in universities

Figure 7. Mauritius model and its outcomes



Another related difference is that Mauritian families place a strong emphasis on the importance of education in preparation for a career. From an early age, most Mauritian parents teach their children that education is the path to a good career and a better life. The merit-based admission to the free university creates a highly competitive environment. To improve their children's chances of admission, a high percentage of Mauritian parents send their high-school-age children to after-school tutoring sessions and pressure them to study hard.

Another major cultural difference is that Mauritian boys and girls are taught in separate but equal high schools. Research suggests that girls attending such schools have higher self-confidence and achieve greater career success than those attending coed schools (Coursten & Coleman, 1996). We believe that such separation creates an environment that frees Mauritian girls to discover their academic strengths. The evidence for this is that Mauritian girls do at least as well as boys on the standard entrance exam and have equal chances for admission to the program of their choice at UoM. Moreover, computing-related programs are not perceived as male disciplines because girls have the chance to discover their aptitudes in this separate, nurturing environment.

A final difference is that when a Mauritian student has been admitted to the university, she or he cannot easily change her or his major program. To change one's major program, a student must leave the university and reapply for admission to the new program the following year. This, coupled with UoM's competitive, merit-based admission process, helps the CSE department retain its students (both male and female) because once admitted, most students are loath to jeopardize their prospects by reentering that fierce competition.

The Mauritius Model

We can summarize and enumerate the Mauritian cultural differences as follows.

1. Mauritian families see education as the key to a good career and life. This is an essential foundation for any country seeking to become stronger.
2. The Mauritian government has actively and visibly promoted computing with its IT initiative to become a cyber-island. This has impressed the importance of IT on its national culture, making IT studies and careers honorable, prestigious, and patriotic. It has also encouraged increasing numbers of Mauritian women to consider a computing-related career.
3. Mauritian students are taught in single-sex high schools. This allows Mauritian girls to discover their aptitudes and interests in an environment that is free of gender-based distractions. Because of this and the preceding differences, Mauritian girls are applying to computing-related UoM programs in increasing numbers.
4. Once admitted to a UoM program, students cannot easily change their majors. Because of this, students who are dissatisfied with their CSE programs (e.g., female students discouraged by sexist male peers) are less likely to switch to different programs. This in turn helps the CSE department retain the young women who begin its programs.
5. Access to a university education is not guaranteed in Mauritius. This motivates students admitted to UoM to make the most of the opportunity they have been given. This and the preceding differences are helping Mauritian women graduate from CSE programs in increasing numbers.

We like to visualize these five differences as a tower in which each level builds upon the ones beneath it to produce a positive outcome, as shown in Figure 7.

We conjecture that each of the outcomes in Figure 7 must be achieved to increase the representation of women in IT. For example, if a girl values education but will not consider an IT career, she will not enroll in an IT program. Similarly, if she enrolls in but does not remain in an IT program, she will not graduate from an IT program. Taken together, the achievement of these outcomes forms a pipeline that guides a girl toward the successful completion of an IT program.

We believe that the tower of cultural differences shown in Figure 7 is how Mauritius achieves these outcomes. This tower thus forms a model, the Mauritius model, of one way to increase the representation of women in IT.

Some pieces of this model could be adopted in ASG countries (e.g., national IT initiatives, gender-separate but equal high schools). Other pieces of the Mauritius model seem harder to adopt in ASG countries, at least in the United States (e.g., limiting the ability of a student to change her or his major).

If we cannot use a given piece of the Mauritius model to achieve a given outcome, we in the ASG countries must find an alternative means of achieving that outcome. For example, special IT programs for middle-school girls might provide an alternative means for ASG countries to get girls to consider an IT-related career. Special IT programs for high-school girls might provide a means of getting girls to enroll in an IT-related program. Positive female role models and mentoring relationships might provide a means of attracting young women to and retaining young women in IT-related programs.

FUTURE TRENDS

Since 1990, the University of Mauritius has done very well at increasing the representation of women in its computing-related programs. This achievement is all the more remarkable because admission to UoM is based solely on a student's merit and area of interest. Put differently, there are no special programs at UoM to increase the representation of women or other underrepresented groups. We hope that this happy accident of increasing representation will continue in the future.

Unanswered questions that could benefit from further study in Mauritius include the following.

- UoM students are admitted to the unfilled programs that are highest on their lists of choices. It would be interesting to know the number of CSE women for whom CSE was their first choice, the number for whom it was their second choice, and so on. This would provide a more precise gauge of how interested Mauritian women are in computing-related studies.
- In the late 1990s, the Mauritian government began its IT initiative to make Mauritius a cyber-island. One part of this initiative was the September 2001 opening of the new fee-based University of Technology, Mauritius (UTM), to expand the country's ability to train IT professionals. UTM offers bachelor's degrees in computer applications (CA), software engineering (SE), information-technology-enabled services (ITES), business informatics (BI), and computer science with network security (CSNS). The first students graduated from UTM's SE and BI programs in 2004, with about five students graduating from each program. We have no other data from UTM, so it would be interesting to see how the gender representation at UTM compares with that at UoM.
- The authors are computer scientists, not sociologists, so the preceding cultural-factors and Mauritius-model sections are conjectural. We would welcome a less conjectural analysis of the Mauritius phenomenon by a sociologist.

CONCLUSION

Women in Mauritius are choosing and graduating from computing-related disciplines in increasing numbers, even as those numbers are dropping in ASG countries. Mauritian culture is different from that of ASG countries in several ways, including the following.

1. Mauritian families see education as the key to success.
2. The Mauritian government is aggressively promoting IT.
3. Mauritian students are taught in single-sex high schools.
4. Mauritian students cannot easily change their major programs.
5. Mauritian students are highly motivated and career oriented.

Together, these differences form a model that explains why young Mauritian women consider, enroll in, remain in, and graduate from the CSE programs at UoM at rates far exceeding those of ASG countries.

To increase the representation of women in IT in ASG countries, we must succeed in getting academically serious young women to consider, enroll in, remain in, and graduate from our own IT-related programs.

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KEY TERMS

ASG Country: A country whose primary ethnicity or culture is Anglo, Scandinavian, or Germanic, or that has its origin in one of these regions.

CSE: The Department of Computer Science and Engineering at the University of Mauritius.

IT Initiative: A multifaceted national program sponsored by the government of Mauritius to turn the country into a cyber-island.

Mauritius: A 25-mile by 40-mile island nation of 1.2 million people, located about 500 miles east of Madagascar.

Mauritius Model: Five Mauritian cultural differences, the combination of which has increased the percentage of women in computing-related programs at the University of Mauritius.

UoM (University of Mauritius): Until 2001, it was the sole university of Mauritius and the main source of the nation's IT professionals.

UTM (University of Technology, Mauritius): A university opened in September 2001 by the government of Mauritius to help the country expand its population of IT professionals as part of its IT initiative.

Women Entrepreneurs in Finnish ICT Industry

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INTRODUCTION

The Nordic countries—Finland, Denmark, Norway, and Sweden—offer interesting material to investigate gendering processes. In these societies, gender equality policy has long traditions and many propagated goals have been researched: women and men participate in paid work almost to the same extent; women make a significant contribution to family income, because it rests on a dual income model; public, low cost day-care is available to all children over one year of age; women's level of education is exceeding that of men's. Yet, the labour market is notoriously segregated both horizontally, meaning that men and women work in different occupations, and vertically meaning that men hold high ranking positions in public and private organisations. The focal phenomenon of this article, entrepreneurship shows even more profound segregation with women and men enterprising in different lines of business and within the same lines of business in different branches (Kovalainen, 1995; Spilling & Berg, 2000).

Nordic experience shows that gaining access to men-only spaces does not bring the same prestige, make women equally influential, and powerful as men. Thus, the question remains what are the processes which hinder women entrepreneurs from achieving a significant position? The article offers one possible answer by reporting a study by Pietiläinen (2002) who set out to investigate what kinds of spaces for entrepreneurial action women business owners are offered in the Finnish information and communication technology (ICT) industry.

BACKGROUND

Since the early 1980s, academic interest in women entrepreneurs has increased steadily due to the increasing impact businesses owned by women have on society and the economy. Presently female entrepreneurship research is a subfield of entrepreneurship studies (Carter, Anderson, & Shaw 2001). In this field, scholars are united in their view that women's unequal access to economic power needs to be changed.

Within the field, researchers differ in their views about the sources of gender inequality and the means to analyse and battle it. This, of course, is based on the presumption that inequality is undesirable. In Pietiläinen's study the different views were categorised into three broad empowerment agendas in female entrepreneurship literature. Table 1 displays the three feminist lines of inquiry. The first two lines of inquiry provided the study with analytical concepts which aided the interpretation of gendering processes in the empirical material. The third approach "doing gender," was followed throughout the research process.

Gender Equality

The overwhelming majority of research is inspired by "gender equality." Researchers following this line of inquiry believe that overt discrimination prevents women from realising their full entrepreneurial potential (Fischer, Reuber, & Dyke, 1993). Over the years they have devoted much research into identifying what kinds of barriers women have to overcome before, during, and after a business start up. Results point to gender differences and cultural prejudices. The latter have been identified as the biggest obstacle for entrepreneurial women. Repeatedly, they encounter gender-based stereotyping and suffer from lack of credibility and support (e.g., Carter & Kolvereid, 1998; Fabowale & Orser, 1995; Kolvereid, Shane, & Westhead, 1993).

Voice to Women

Researchers who are interested in investigating women entrepreneurs' "own voice" and experiences start from the assumption that the source of inequality is women's lifetime experiences of subjugation. These studies represent the second empowerment agenda. Socialization into a woman's position results in uniquely female worldview, and consequently, in different entrepreneurial behaviours than men's (Ahl, 2002). This research has excelled in revealing that women's entrepreneurial choices are greatly shaped by the overall pattern of women's labour market behaviour, life style, and stage of life (e.g., Brush, 1992; Goffee & Scase, 1985; Green & Cohen, 1995; Sundin & Holmquist, 1989).

Doing Gender

Recently, a growing number of European researchers claim that inequality in entrepreneurship is a result of gendering processes which privilege male-typical behaviours and values. Their proposition is to make use of the concept "doing gender" (West & Zimmerman, 1991). These scholars suggest that researchers of female entrepreneurship need to take a critical look at their own empowerment agendas to move forward. Critical assessment of research inspired by "gender equality" thinking shows that gender equality, in fact, diverts attention away from deeply masculine connotations of entrepreneurship. "Voice to women," in turn, suffers from searching for unique female behaviours, which does more to mystify female experience than to give space for real life women entrepreneurs with their differing aspirations, possibilities, and life strategies. The proponents of "doing gender" approach suggest that effort should be put into exposing the gendered power relations at work in entrepreneurship (Kovalainen, 1995), and move toward change in gendered social and symbolic arrangements governing entrepreneurial activity (Ahl, 2002).

METHODS AND MATERIALS

Pietiläinen's study (ibid.) applied qualitative methodology to identify what kinds of spaces for entrepreneurial action women business owners are offered in ICT industry. Textual analysis was used on a city's strategy documents, media articles about one female-owned new media company Nicefactory Ltd, and transcribed interviews with the company's female owner-entrepreneurs. Empirical material covered the years 1997-2002. As to the theoretical background gender was examined as doing. "Doing gender" approach was chosen because it allowed for studying gender as a process, not as individual

Table 1. Three lines of feminist inquiry in female entrepeneurship literature

Line of Inquiry	Source of Inequality	Analytical Concepts	Empowerment Agenda	Examples of Research
Gender equality	Overt discrimination of women	Gender stereotyping; gender differences	Removal of obstacles; incentives to women; change of attitudes	Kolvereid, Shane, & Westhead, 1993
Voice to women	Women's experiences of subjugation	Female typical qualities and characteristics; Female typical experiences	Creating women-only opportunities and spaces; raising consciousness; change of attitudes	Brush, 1992; Sundin & Holmquist, 1989
Doing gender	Gendering processes which give power to men and male typical behaviours	Gendered social and symbolic arrangements; gendered power relations; hidden masculine connotations	Exposing gendered power relations; change in social + symbolic arrangements; change of attitudes	Ahl, 2002; Kovalainen, 1995

characteristics. In the study, "doing gender" was used both as a theoretical concept and methodological means. Theoretically, "doing gender" allowed focusing away from understanding just the individual entrepreneur to understanding how gendered social and symbolic arrangements of entrepreneurship in ICT industry are shaped. Methodologically, "doing gender" focused qualitative analysis on that continuous meaning making of gender which is embedded in the every-day activities of people and organisations involved.

THE CASE-COMPANY AND CONTEXT OF THE STUDY

The focal company of the study, Tampere based Nicefactory Ltd, was conceived when its owners observed the lack of well-produced Web contents. Specifically they wanted to provide a Web service to female Internet users. The two founding partners of Nicefactory Ltd. worked in radio, TV and print media for an extended period of time before establishing their own company. One of the partners has a university degree in naval engineering and the other holds a master's degree in social psychology. In autumn 1998, they launched their first Web site, www.Nicehouse.fi with content featuring information and discussions about various family-related topics. Their next Web site, www.49er.net, providing real time sailing race information, was launched shortly thereafter. In 2000, a technical university commissioned Nicefactory Ltd. to create a customized learning environment, an opportunity for the company to develop yet another type of Internet content service. The same year, Nicefactory Ltd. launched two new Web sites: www.Addiktio.net, which focuses on "all kinds of addictions," and www.Sooda.com, a Web service designed primarily for teenage girls, but expanded to attract teenage boys, too. Since its launch, Sooda.com has become one of the most popular Finnish Web communities.

At the turn of the century, Finland was well known for its excellence in information and communication technology (ICT) and a highly developed, widespread Internet culture. Nokia had lead the Finnish ICT-sector's growth and rapid internationalization. There was and still is extensive technological knowledge at all levels of society, and Finns are eager to use the latest technological innovations. What was still lacking from this success story, however, was an innovative and user-friendly media culture and business-oriented content production with international potential (e.g., Castells & Himanen, 2001; Tarkka & Mäkelä, 2002). While the ICT-sector had largely developed through technological innovations the content innovations and production had lagged behind.

ICTs—A World without Women

The masculine image of the ICT industry is so strong that it seems paradoxical to link women and entrepreneurship in that industry. Most explicitly, ICT-industry is a world without women: male engineers run the businesses, develop, and market the services/products while women tend to be responsible for office work (Vehviläinen, 1997) and human resources function. Women business leaders are bound to stand out and draw attention as a rarity. A well-known example is Carly Fiorino's position at Hewlett Packard.

When it comes to the definitions that are widely used to describe ICT business, a more, subtle, yet distinctively masculine image emerges (Lie, 1995). It is unanimously recognised that the core competencies of the industry build upon high-tech know how (e.g., Lovio, 1993). From this acknowledgment, it is a small step to define technical accomplishments as groundbreaking innovations and maintain that more is to be expected due to heavy investments in product development (e.g., Schienstock, 2004). Expectations are also supported by the qualities of the people working in the industry. Men who found ICT companies tend to have (technical) degrees. This fact is believed to indicate that the companies are more strategically oriented, more prepared to growth, and more prone to risk taking than the case is in an average start-up.

THREE CONSTRUCTS OF SPACE FOR WOMEN'S ENTREPRENEURSHIP

Based on the empirical analysis, Pietiläinen's (2002) study resulted in three constructs for understanding processes which hinder women entrepreneurs from achieving a more significant position in the Finnish

ICT business. The three constructs are "gender neutral entrepreneurship," "female entrepreneurship," and "powerful women's entrepreneurship."

The first construct, "gender neutral entrepreneurship," gives support to the notion that entrepreneurship, although a human activity is not linked to gender in any fundamental way. The construct is most explicit in strategic management discourse, which becomes important when business opportunities, future growth, and internationalisation or globalisation are visioned. These topics point to the issues which need entrepreneurs' attention in emerging businesses.

The construct provides interpretations to fade out femininities that female entrepreneurs inevitably bring with them to entrepreneurship. The gender neutrality is achieved by meaning making, which first, excludes femininities from the meaning horizon of the category of "entrepreneur" (see also Ahl, 2002) and then, equates selected masculinities of competitiveness, rationality, instrumentality, and control with the ideal entrepreneurial figure.

As such, "gender neutral entrepreneurship" provides a highly appealing space of action to a woman. The idea of that female sex presents an exception can be overcome. This space could secure the position of the "real entrepreneur" for women as well, not only for male business owners. There is, of course, a price attached. It is not easy to find acceptable ways to display femininities as they threaten to expose the otherwise hidden masculinities of the "entrepreneur."

As embodied physical women, female entrepreneurs remind constantly that gender cannot be excluded from entrepreneurship for good. The second construct is labelled "female entrepreneurship." It deals with the femininities and maintains that there is a distinction between "entrepreneurship" and "female entrepreneurship." The distinction rests on gender hierarchy, which makes it rational to relegate gender to women business owners and consider their business actions as gendered exceptions. The construct offers space for action, which many women entrepreneurs are not comfortable with. Experiences of gender stereotyping and (dis)credibility problems give no explanation as to why marginalise women's entrepreneurship by yet another separation. The construct opens up also space for positive action, because it allows for appreciative understanding that living the life of a woman creates a valuable source of business information. Often, women's preferences and ways of doing things are easily bypassed in service and product development as well as marketing, because gender hierarchy prevents from seeing the value of women's activities.

The third construct, "powerful women's entrepreneurship", couples female entrepreneurship with the success stories of start-up businesses in the new economy. It represents selected women entrepreneurs as outstanding representatives of female sex in the male world. The construct dominates media's way of representing female entrepreneurs in the new media business. The positive side of space for action is that media has the power to increase general public's awareness of women's business start-ups. Young men's ICT-business endeavors dominate media publicity and therefore coverage of women's efforts makes a difference. Although women entrepreneurs are treated as a special category, the construct gives meaning making resources to modify particularities of female entrepreneurship into prime means of entrepreneurial advancement.

Ambiguous Spaces for Women's Entrepreneurship

The three constructs offer conflicting and ambiguous spaces for female entrepreneurship in ICT-industry. "Gender neutral entrepreneurship" is a construct which is deeply rooted in strategic management discourse. It is one of the most powerful streams of thinking and acting in the present business world. This connection means that strategic management offers no easy support for entrepreneurial initiative by women, especially if it is innovative in the business field.

"Female entrepreneurship" is more open to women's entrepreneurial behaviour. However, it creates a boundary between entrepreneurship and women's entrepreneurship. The boundary is based on hierarchy, where women's business represents "lesser" form of economic activity. The culturally embedded hierarchy is hard to overcome by individual women.

Yet another type of marginalisation takes place by the construct "powerful women's entrepreneurship." Here, media creates an ideal image of a female entrepreneur and presents it to the public. When a real-life woman compares herself to the ideal, she will most likely find herself lacking the qualities, skills and time to perform within the standards set by the ideal image. Research shows that many business women experience feelings of being inadequate when they think that they are not able to meet the expectations created by the ideal.

Typically, people build their entrepreneurial identities on professional identity which is supported by education and work experience (Hytti, 2003). Ambiguity and conflict stemming from the three constructs refer to the puzzling experience that sex as an anatomical fact presents a more decisive factor to evaluate an entrepreneur's business competence than professional and business experience. In these moments of evaluation, gender is at the same time highly visible and virtually invisible. This is due to fact that entrepreneurship is invisibly male gendered, but thought of as gender neutral and, at the same time, visibly gendered when the actors are women. For individual women entrepreneurs, the dynamic interplay between the visible gendering and the invisible, seemingly gender neutral gendering presents a "rough" field to practise entrepreneurship.

FUTURE TRENDS

The study by Pietiläinen (2002) points out that more research is needed to investigate gender as an ongoing process of meaning making. There is abundant evidence, that to an individual woman entrepreneur, the key question is how to successfully share time between entrepreneurial and personal responsibilities. However, the means by which balancing is achieved by women entrepreneurs, has been overlooked by researcher. The pressure of balancing tends to increase in knowledge intensive business (e.g., ICT-business) where long working hours, project based work, and travel are prevalent practices. What has attracted less attention is that typically, entrepreneurship is associated with for-profit activities in the public sphere and entrepreneurs' needs of nurture and emotional support are seen as private matters, not belonging to for-profit world. The division between work performed in public and work performed in the private reveals that entrepreneurship is considered gender neutral, public activity. Individual entrepreneurs, instead, are gendered and therefore gender "intervenes" to female and male typical ways of coping with the division. Consequently, we need new, critical conceptualisations of entrepreneurship, to overcome deeply held divisions and hierarchies.

CONCLUSION

Female entrepreneurship research shows that economic factors explain only partially women's entrepreneurship. A fairly recent newcomer in this line of inquiry, doing gender studies contribute to understanding that interpretations of entrepreneurship create spaces which men and women are able to occupy differently. These studies alter the theoretical emphasis of entrepreneurship research from examining gender differences per se to analysing how such differences are produced. The theoretical usefulness of examining individual women is questioned. The challenge is to relinquish the stable notions of gender differences and similarities between women's and men's entrepreneurship, popular in the extant literature. Even if there are no clear references to gender, there are seemingly neutral articulations that produce different material outcomes for women. In this sense, meaning making of entrepreneurship rearticulates the power imbalance informing relations of gender.

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KEY TERMS

Doing Gender: A gender theoretical line of reasoning that gender is a process of power which first, creates and maintains differences between the sexes and second, constructs a hierarchy to the benefit of men and masculinities.

Empowerment Agenda: A proposal of actions which are needed to enable discriminated people to act upon their own interests.

Gender-Based Stereotyping: Using common sense criteria to categorise people into males and females. The criteria include assumptions about gender appropriate characteristics, behaviours, and physical qualities.

Gender Equality: A gender theoretical line of reasoning that overt discrimination prevents women from realising their full potential.

Women's Own Voice: A gender theoretical line of reasoning that meanings and interpretations a woman or a group of women invent and use to make sense of their experiences remain silenced due to prevailing gender order.

W

Women in Computing in the Czech Republic

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INTRODUCTION

While the countries of Western Europe and the USA are mostly in control of the design and construction of computing technology, the numbers of women actively involved in this process are very low and decreasing. The Czech Republic is an Eastern European country with highly developed system of tertiary computing education and levels of computer usage comparable to Western Europe. Whereas under capitalist regimes of the period equal opportunities legislation has often been achieved despite Government resistance, Communism built it into its constitution, and professed equality of men and women in every field of human activity. Publicly and in the national subconscious that equality became a reality. However, at a time when Western European governments and European Union (EU) legislators are finally awakening to the unequal position of women in technology, it is a perception that invites closer inspection. This article is based on a set of interviews carried out in the Czech Republic in August 2004 and a collection of official reports and quantitative data published in the Czech Republic between 2002 and 2004. The aim was to find out what has the new Czech regime done about gender equality in the field of computing and what importance the Czech officialdom assigns to the perception of equality. For comparisons this article assumes that the reader is acquainted with gender and computing debates in the "West."

BACKGROUND

Gender Equality Before and After the Velvet Revolution

The Czech Republic (then part of Czechoslovakia) became a "capitalist country" in the change of regime that occurred during the Velvet Revolution of November 1989 and subsequently became a member country of the European Union (EU) in May 2004. In preparation for its entry to the EU and as a reaction to direct criticism by the United Nations, the Czech political leadership was forced to follow gender equality movements, gender mainstreaming, and EU legislation and include gender equality on the country's political agenda.

During the years 1948-1989, the communist regime guaranteed the right to work for every citizen, stated quotas for women's employment and guaranteed women's rights in the constitution. The general population had no opportunity, nor the necessity, to discuss the meaning of gender or women's equal rights. Taking this "guaranteed equality" for granted, the population slipped deeper into accepting biologically and socially deterministic gendered views of the roles of men and women in society. While this supposed equality applied also in further and higher education, views of women not being suitable to study technology, and engineering prevailed and very few women applied. Most women worked in administration, school education, services and caring professions, men worked in fields of engineering, technology and were represented in large numbers in specialist medicine, politics, university education, and research.

When the communist regime was overthrown, gender initiatives developed mainly from the former dissident movement, the Czech Sociological Institute and interested individual academics. Based mainly on The Czech Sociological Institute's findings, the Czech Helsinki Committee reported in 1996 about the human rights situation in the Czech Republic. This very lengthy report contains a section on "Some aspects of women's rights in the Czech Republic" which mentions sexual harassment and unequal treatment in places of employment, advertising, pay, and the existence of glass ceilings. All this was described as almost a "Czech cultural norm" (a term coined by Hana Havelkova).

In 1990, the sociologist Dr. Jirina Siklova founded The Gender Studies Centre, a women's NGO. It is an educational, information and advice centre for equal opportunities. It has its own library and Web site, a number of publications, and participates in national and international research projects. During a brief examination, I found that the library contains little about women in science and technology and nothing on women in computing.

By 1996, the Czech government was forced to begin the debate on equal rights for men and women in Czech society and in April 1998 it agreed its "Action Plan of Priorities and Activities for Enforcement of Equality of Men and Women." The government decreed that each of its departments had to co-operate with women's organisations.

Women in Computing in the Development of Government Gender Policies

The Ministry of Work and Social Affairs has been charged with collecting and publishing gender information and advising the Government. It has established a Department for Equal Opportunities for Women and Men, which publishes (since 1998) an annual "Aggregate Report on Fulfilment of Priorities and Activities of the Government for Enforcement of Equality of Men and Women." In October 2001, the Government established its advisory body The Council for Equal Opportunities of Men and Women with members representing ministries and NGOs (MPSV, 2004). The one ministry, which is *not* represented, is the Ministry of Informatics. The Aggregate Reports are only presented to the government after individual ministerial reports have been debated and accepted by this council.

The Ministry of Work and Social Affairs publishes a range of reports containing gendered statistics and reports on fulfilment of international agreements and recommendations (e.g., Beijing+5). There appears to be no specific interest in women in science and technology in all these publications. Most of them stress that equal rights and opportunities at work are guaranteed by national legislation. By such reports the ministry is trying to demonstrate to the EU that gender inequality at work does not exist. This appears to be in strict contrast with situations reported by the Gender Centre or the Czech Sociological Institute (Study on Paternity Leave, 2003). Using European Union grants, the government has published material intended to educate employees about gender equality. This material has been distributed to government departments and local councils. There seems to be no evaluation of their direct influence on official decision-making and it was not in evidence during my interview at the Ministry of Informatics.

In my search for evidence of understanding of questions of gender and computing, I sent a questionnaire to the Minister for Informatics. His response can be summarised as follows: women in the Czech Republic do have equal opportunities in the workplace and in access to higher education. If they are under-represented in the IT industry, then it is because they do not choose to enter that field. Admittedly a stronger emphasis needs to be put on IT education, but this is the responsibility of the Ministry of Education, and the wider area of equal opportunities is the responsibility of the Ministry of Work and Social Affairs. The role of the Ministry of Informatics seems to be restricted to offering money for training courses in ICT literacy (National Programme).

The Commission for Informatics and Telecommunication—an advisory body on questions of policy in Informatics to the ruling Czech Social Democratic Party—comprises 30 members, of whom just one is a woman. An interview with two male founding members of the Commission confirmed that questions of gender and equal opportunities never reach the agenda. Neither saw any point in trying to persuade women to work in an industry where they "do not want to be." One of them believed that glass ceilings do not exist in the Czech Republic and that women do not wish to be competitive and "collect trophies," and therefore have no need to enter higher management positions. He also "knew" that women do not have the ability to manage technical university education, particularly mathematics, as they possess "different logical skills."

It is not difficult to infer the nature of the political advice that is informed by this kind of gender stereotyping.

Women in Computing in Higher Education

In general, Czech universities are divided into technical and humanities universities. Both types offer some teaching in computing, but it is the technical universities that students would choose to study computer science and informatics. A brief study of the Web pages of computer science/informatics/ engineering faculties of the two main Czech technical universities in Prague and Brno and the two main humanities universities in both cities (accessed 10.9.2004) revealed that no gendered statistics of staff and students have been published. As the Czech language differentiates clearly between male and female names, I was able to do a head count of men and women staff and PhD students. Of the total of 209 full time members of staff only 15 (7%) were women and of the total of 179 PhD students only one was a woman. None of the women academics was in a position of dean (faculty) or professorial (department) management. Only the Masaryk University Brno published their list of students, which showed that of the 1390 undergraduate student only 97 (7%) were women.

The Czech Statistical Office (2003) publishes gendered statistics of the total numbers of men and women students but these are not broken down by individual faculties or subject areas. Table 1 is based on figures available for 2001/02.

There are in total almost equal numbers of women and men entering university education. Some fields, like pedagogy or nursing, are heavily populated by female students. The difference between technical universities (Prague and Brno) and those primarily concerned with humanities (Charles and Masaryk) is striking. The humanities universities have much higher numbers of women in traditional female fields and thus the statistics hide the low numbers of women in their departments of computing or informatics. Table 2, which shows the numbers of students in the field of "electronics, telecommunication, and computer technologies" for the whole of the Czech Republic, presents a bleak picture.

The Ministry of Work and Social Affairs (December 2003, p. 38) states that "...it is mostly women that study social sciences and services fields, most frequently medicine and pharmacy. We find few women in technical and natural science fields..." It also says (p. 36) that while there are slightly more women in bachelors' degrees, women only account for about one third of all PhD students. Certainly among these there are almost none in computing or informatics. Again while observing the shortages, the ministry has no analytical explanation of these findings, or suggestions for improving the situation.

An interview with an employee responsible for equal opportunities at the Czech Ministry of Education revealed complete inactivity in this matter. There exists in the Czech Republic a Centre for the Study of University Education, established in 1991 as a state-funded institute of the Ministry of Education. Its mission is "to collect, analyze, collate, and disseminate information concerning higher education and research policy." This Centre has published a report evaluating dropout rates from technical universities in the Czech Republic (Menclova, Bastova, Konradova, 2004). There is a section entitled Sex in this article, which translates as follows: "Because we are investigating technical fields of university studies, the substantial majority (73.5%) of men over women (26.5%) is quite natural" (p. 9). The report offers no gendered data, no gender analysis and no proportions of men and women in the 50% dropout rate. As a government advisory body, this institution may be able to influence political decisions, however there appears to be no evidence that its gender reports are being actively used.

Table 1.

University	Men students	Women students
Czech universities **in total**	114,322	105,192 (48%)
Technical University Prague	17,925	**3,357 (16%)**
Technical University Brno	12,329	**2,765 (18%)**
Charles University Prague (humanities)	17,743	23,180 (57%)
Masaryk University Brno (humanities)	9,678	12,543 (56%)

Table 2.

	Total no. of students	Total women students	Men graduated in 2001/02	Women graduated in 2001/02
2001/02	11,875	458 (3.9%)	1,413	32 (2.2%)
2002/03	14,859	678 (4.6%)	1,619	64 (3.8%)

Women in Computing Employment

While it is difficult to find data on women in computing in the Czech education system, it is almost impossible to find data on the numbers and positions of women in the computing and informatics industry. In 2002 there were 194,000 people who worked in information and communication technologies (ICT). This represents 4% of the total labour force in the Czech Republic (source http://www.czso.cz, provided by Kristova). As elsewhere in the world the definition of "the industry" is not stated and thus some may argue that for 4% the questions of equality are not substantially important.

The Czech Statistical Office has two classification categories, which relate to computing and ICT: "technical, health, and pedagogic workers" and "research and specialist professional workers." Taken together, these categories represent 30% of the total Czech work force, and in both of them women earned almost 30% less than men in 2001. A figure of 30% is not quite so easily dismissed.

An interview with an employee from the Gender Department of the Ministry of Work and Social Affairs confirmed, that while the ministry is responsible for the National Gender Action Plan, the questions of equal opportunities for women and men in employment are of no interest to the ministry. It is predominantly interested in women's unemployment, women's access to employment, and sees no reason for collecting statistical or other data on women employed in any particular field.

An interview with the personnel director of one of the five largest Czech IT companies revealed that of the 350 workers 74% were men, of whom 69% had a university education. Of the 26% who were female, only 33% had a university education, and most did not work in technical jobs. The company employed 241 non-administrative/technical staff for whom gendered statistics are not collected. 2/10 women were employed as top managers, and 4/18 women in middle management.

FUTURE TRENDS

The gender debate and most research in the Czech Republic focuses on issues of domestic violence, trafficking, reproductive health and gender equality education, and has not engaged with ICT issues (Simerska & Fialova, 2004).

There are exceptions to this trend. Sometimes these are committed individuals like the PhD student in Prague whose thesis is on gender and computing, and the Gender Studies Centre researcher who is the ICT & Economy project manager and participates in several international IT and gender related initiatives. The latter is co-author of a report entitled "Bridging the Gender Digital Divide in Central and Eastern Europe" (2004), which concludes that women in this part of the world are under-represented at all levels within ICT initiatives. She also criticises inadequate integration of gender and/or women-specific issues, lack of gendered statistics and unequal access to ICT training. She is dismissive of ministerial initiatives, seeing them as wholly ineffective.

Following the European Technology Assessment Network (ETAN) report on Women and Science in 1999 *Promoting Excellence through Mainstreaming Gender Equality*, the Czech gender specialists have also published an explanatory educational booklet on the glass ceiling for women in science (Linkova, Saldova, Cervinkova, 2002). The workers interviewed at Ministry of Informatics responsible for equality had never seen it.

Women in Science is a "National Contact Centre" with a Web presence, which elects a woman scientist every month, publishes Czech and international news on women and science and a quarterly magazine called Kontext. The April 2004 issue contains an article about Aida Lovelace. I am not clear what political influence this Centre has and how widely it is known among the population.

An important and welcome contribution to the debate on gender politics is the Shadow Report on Equal Opportunities (Bouckova et al., 2004). The Shadow Report is highly critical of the official Aggregate Reports mentioned earlier and accuses the government of inaccuracies, misreporting, little proactivity, misusing statistics to paint a rosier picture of the position of women in the Czech Republic and its own activity in this field, and of not acting on its own recommendations. The report also criticises the Ministry of Education for the lack of gender sensitive education, and for not fulfilling any of the "gender priorities" set for 2003. In the field of science and research, it points out that despite many acknowledged problems like the "brain drain" and lack of money, the accepted norm seems to be no gendered statistics, low gender awareness, lack of support for research in the areas of gender, stereotyping of researchers, financial discrimination and lack of equal opportunities.

The report makes a number of recommendations for improvement, but there has been insufficient time since its publication to assess what impact it may have.

CONCLUSION

Under pressure from the EU, the Czech government appears to expend a great deal of energy on promoting equal rights for women and men. A government committee, educational material, annual reports and a dedicated person at each ministry all now exist. While the government can call on an extensive body of statistical and educational material to back up its claims of success in the field of gender equality, little evidence exists that there has been any real change in public opinion or behaviour. There is an overwhelming impression that gender equality reports are published with the primary objective of satisfying EU requirements and directives.

There is no evidence that political circles have even begun to perceive the shortage of women in technology and ICT as a problem. Although a grant application for a gender and ICT project has been turned down (Simerska), the ministries are "not aware" of any application, and are not issuing any calls for projects of this nature. There appears to be a belief that higher levels of general computer literacy will automatically lead to more women choosing IT as a field to study and work in. There is also no awareness of the need for critical evaluation of the possibility that social conditioning and technological gendered prejudices and stereotypes might be the reason for the unequal position of women in this field.

Communism stifled any debate on gender stereotypes and gender equality and the time that has lapsed since the Velvet Revolution seems to have been too short to reverse this process. There are pockets of refreshing enthusiasm for change among gender researchers of the Gender Studies Centre, but the overwhelming impression is of a Czech officialdom with a bureaucratic attitude to report writing which has little analytical content.

NOTE

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KEY TERMS

Czech Government Type: Parliamentary democracy with a president and a prime minister, bicameral Parliament which consists of the Senate and the Chamber of Deputies, regional and local councils and ministries in expected fields.

Czech Republic: A landlocked Central European country, capital Prague (Praha), bordering Germany, Poland, Slovakia and Austria. It has two regions Bohemia and Moravia and 10.5 million inhabitants. As of May 1, 2005 it is a member state of the European Union.

Humanities University: A university delivering degrees in humanities. The Czech Republic also has specialised agricultural, military and economic universities.

Technical University: A university delivering degrees in science and technology subjects.

Velvet Revolution: Term given to a peaceful change of regime from Communism to Capitalism in the Czech Republic in November 1989.

Women in Technology in Sub-Saharan Africa

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INTRODUCTION

International research has shown that in most countries, there are few women studying towards *information technology* (IT) careers (Galpin, 2002), and there is much research, particularly in the United States (U.S.), United Kingdom (UK) and Australia into why this is the case (Gürer & Camp, 2002). This article considers the situation in *sub-Saharan Africa* and focuses on women's involvement in the generation and creation of *information and communication technologies* (ICTs) in sub-Saharan Africa, as opposed to ICT use in sub-Saharan Africa, which is considered elsewhere in this volume. There are a number of aspects to the generation and creation of ICTs: how women are involved in this process as IT professionals and how they are educated for these careers, as well how technology can be used appropriately within the specific conditions of sub-Saharan Africa. ICTs will be considered in the broadest sense of the word, covering all electronic technologies, from computers and networking to radio and television.

Women's participation is important: The World Summit on the Information Society (WSIS) Gender Caucus (www.genderwsis.org) has identified women's involvement in the design and development of technology as well as technology management policy, as key principles for the information society. Marcelle (2001) emphasizes the necessity for African women to become involved in technological and scientific areas, including "computer science, software engineering, network design, network management and related disciplines" (Marcelle, 2001, para. 15) to create an information society appropriate for African women. The diversity of those involved in design leads to higher-quality and more appropriate technological solutions (Borg, 2002; Lazowska, 2002).

BACKGROUND

Sub-Saharan Africa has a population of 641 million, young (almost half under 15) and rural (35% urban). Significant problems are undernourishment, poverty and HIV/AIDS (United Nations Development Programme (UNDP), 2004). All the countries in sub-Saharan Africa are classified as developing countries. Some countries are relatively wealthy, such as Mauritius, South Africa, and Nigeria, but have large wealth disparities within their populations. Women in sub-Saharan Africa are expected to focus on the home, they have less access to education and health, and their contribution to family and community is not valued (Huyer, 1997).

Technology and Infrastructure

Per 1,000 people, there are only 15 landlines, 39 cellular subscribers and 10 Internet users (UNDP, 2004). There is less access to electricity in rural areas, so battery, solar-powered or wind-up radios are important.

The higher rate of cellular subscribers is due to liberalization of telecommunications policies and investment in infrastructure by private companies, but these advances benefit mostly those in urban areas. Mbarika, Jensen, and Meso (2002) identify the urban nature of Internet access, lack of telephone infrastructure, high cost of international links and a lack of technical staff as inhibitors of Internet growth in sub-Saharan Africa. However, growth is being stimulated by growing numbers of Internet cafes; a decrease in charges for access; increased mobile telephony, which releases landlines for Internet access; and deregulation of the Internet and telecommunications sector; as well as reduction of import duties on computer equipment (Mbarika et al., 2002).

Historically, African *non-governmental organizations* (*NGOs*) were pioneers in the use of communicating via computer networks in Africa, convinced of their importance in spite of skepticism from people outside Africa (Esterhuysen, 2002). WorkNet (which became SANGONeT) was founded in 1987 and played an important role in the resistance against apartheid in South Africa internationally. In the early 1990s, NGONET provided e-mail services in East Africa, and ESANet linked five universities in East Africa using *FidoNet*. By 1995, 12 sub-Saharan African countries had full Internet connectivity, and by 2000, all countries had permanent Internet connectivity and dial-up ISPs (Levey & Young, 2002).

IT Education

African women have low participation rates in science and technology education (Hafkin & Taggart, 2001). For undergraduate computer science (CS) students, the following rates of female participation occurred (Bunyi, 2004; Galpin, 2002; Hoffman-Barthes, Nair, & Malpede, 1999; Mariro, 1999; South African Qualifications Authority, 2004):

- Botswana, 10% (1998)
- Eritrea, less than 10% (2001)
- Nigerian polytechnics and some universities, around 30% (mid-1990s)
- University of Nairobi, Kenya, 11% (2001)
- Kenyatta University, Kenya, 14.3% (2002/2003)
- University of Makerere, Uganda, 27% (2000)
- Zimbabwean technical colleges, 41.7% (1996).
- South African universities, 31% (2001); technikons, 37% (2001).

In Tanzania, at the Universities of Dar-es-Salam, Sokoine, and Muhimbili in 1995-1996, only 3% of those receiving the Dip. Sci. Informatic qualification were female (Mariro, 1999).

Odedra-Straub (1995) highlights the lack of female lecturing staff at African universities, and that few universities offered CS degrees in the early 1990s. In Madagascar, 11.1% of CS education teachers were female (Mariro, 1999). In contrast, in South Africa in 2001, 46% of CS instruction staff in higher education institutions were female (South African Reference Group on Women in Science and Technology, 2004), which is unexplainably higher than the percentage of female CS graduates.

An attempt to address the imbalance is the Cisco Networking Academy Program Gender Initiative (www.ciscolearning.org/Initiatives/Gender_Initiative.html) which, with NGOs and governments, provides opportunities for women to study networking. African countries involved include Rwanda, South Africa and Uganda. The Department of Women and Gender Studies at Makerere University, Uganda (www.makerere.ac.ug/womenstudies/ict.html) is an approved Cisco Academy and aims to increase the number of women working with ICTs and to change perceptions of computing as a male domain. To date, the majority of students have been female, and its courses cover basic computer skills, networking skills and the use of ICTs in education. Additionally, the Cisco networking qualification allows entry into the undergraduate CS and IT programs (Bantebya-Kyomuhendo, 2004). A similar program was run at the United Nations Economic Commission for Africa in Addis Ababa, which was exclusively for women and covered gender as well as technical issues (Hafkin, 2002).

IT Professionals

With low participation rates at the tertiary level, there is likely to be a low number of women working as IT professionals. There is little data available on this topic (Hafkin, 2003; Odedra-Straub, 1995). In South Africa, only 27% of IT employees were female, and they were more likely to be in sales and marketing, end-user computing, or education and training than in hardware, management or networking (South African Information Technology Industry Strategy, 2000). In sub-Saharan Africa, it seems that women are unlikely to be found in management or system analysis positions, as well as teachers or lecturers of computing courses, although they can be found as programmers and operators (Odedra-Straub, 1995). Similarly, in developing countries, women are more likely to be in low-level jobs relating to word-processing and data entry than in IT management or in jobs designing or maintaining computer systems and programs (Hafkin & Taggart, 2001). Worldwide, there are few women in senior management positions or on the boards of ICT companies, involved in policy, professional and regulatory organizations or employed by government departments responsible for ICT (Hafkin, 2003).

The International Telecommunication Union (ITU) collects statistics on telecommunications staff. In terms of percentage of female staff in 2001, Benin, Burkina Faso, Central African Republic, Ghana, Malawi, Nigeria, and Togo had less than 20%; Angola, Botswana, Côte d'Ivoire, Kenya, Madagascar, Mali, Senegal, South Africa, and Zambia had between 20% and 29%; Guinea, Lesotho, Seychelles, and Tanzania had between 30% and 49%; Eritrea had 51%; Cape Verde 67%; and São Tomé and Principe 78% (ITU, 2003). Hafkin (2003) notes that the inclusion of telephone operators and data-entry staff explain why some countries have high figures, because these positions are usually held by women.

APPROPRIATE USE OF TECHNOLOGY

Although many people in sub-Saharan Africa, particularly in major cities, have access to ICTs in a way very similar to that of Europe and North America, this is not true throughout. Because of lack of infrastructure and development, a standard model of access cannot be assumed (Kole, 2003), and specific solutions are required for the specific conditions. This section lists some of the issues (for a broad assessment of wireless technologies for Africa, see Jensen, 1996; for other examples of technological solutions, see Holmes, 2004).

Wireless Technology

Two examples that use wireless technology to deal with a lack of telecommunications infrastructure are *high-frequency (HF) radio e-mail* and *digital satellite broadcast*. HF radio e-mail is used to provide infrastructure in remote areas of Guinea (Holmes, 2004; Marshall, 2002). The Arid Lands Information Network (ALIN) in East Africa uses digital satellite broadcasting to transfer content that is downloaded to computer via radio (ALIN, 2002).

Content Delivery

Content appropriate for local conditions is crucial, and more organizations are generating their own content, both from generally available Internet material and from African women themselves. A reason for the move towards Internet publication is that the barriers to entry are often lower than for other media, such as print, radio and television (Holmes, 2004).

Locally developed CD-ROMs can use audio and video to provide material in local languages that is accessible to people who are not literate. In Uganda, a CD-ROM titled "Rural Women in Africa: Ideas for Earning Money" was successfully developed for use in telecenters (Mijumbi, 2002).

CD-ROMs and other optical media can also be used to provide information that will not change. This avoids the cost and time often necessary for downloading material via telephone modems with slow speeds, unreliable connections and via international links with limited bandwidth and high latency due to distance. Design of Web sites should also take these technical constraints into consideration.

Information brokering is also important; information is obtained via the Internet, modified for local conditions and then redistributed, possibly in hardcopy or by radio, as well as by computers (Morna & Khan, 2000; Pacific Institute for Women's Health, 2002). This process also happens in reverse; for example, during the Fourth World Conference on Women in Beijing in 1995, comments on draft versions of the Platform Actions were obtained from women's groups via e-mail (Hafkin & Taggart, 2001). Additionally, African women have indigenous knowledge that is important to collect and disseminate (Huyer, 1997), although the introduction of ICTs should lead to the preservation of this knowledge and not its appropriation (Karelse & Sylla, 2000).

Radio

Transmission of information by radio plays a large role in development. A participant at a workshop on empowering rural women noted that "radio is the rural Internet of Africa" (Women'sNet/Dimitra, 2004, p.4). Listening clubs meet to listen to radio programs and then discuss their content, record the discussions and pass them onto women in other areas (Kole, 2003). This permits dissemination of indigenous knowledge, as well as permitting access to radios in areas of extreme poverty. Content and timing of broadcasts are important issues (Women'sNet/Dimitra, 2004).

The Women'sNet Community Radio Pilot Project in South Africa inter-phases ICTs with radio. It works with community radio stations on gender sensitivity, repackaging of information from the Internet for broadcast, and training of women at women's NGOs in ICT skills (Morna & Khan, 2000).

Free/Libre/Open Source Software

An approach to cost reduction, non-dependent development and sustainability is to move away from proprietary software and towards the use of *free/libre/open source software* (*FLOSS*) (Waag Society, 2003). This has had limited application in Africa to date (Kagai & Kimolo, 2004). In 2004, Women'sNet held a workshop for women in Southern Africa to learn about FLOSS focusing on educating technicians, decision makers and end-users (www.womensnet.org.za/FOSS/more.shtml).

FUTURE TRENDS

To ensure that technology is designed so it is appropriate for all of its users and their specific conditions, it is essential that women are involved in the generation and creation of ICTs in positions such as programmers, system designers, information technologists, network specialists, software engineers, system analysts and content developers.

Women's involvement in technology policy decisions is also important. The WSIS Gender Caucus has identified equal participation in decision making as a key principle for the information society. Additionally, gender must be part of national and international ICT policy (Hafkin & Taggart, 2001; Huyer, 1997; Marcelle, 2000). This requires the involvement of women who are IT professionals. Hence, it is crucial that there is a concerted effort on behalf of national governments in sub-Saharan Africa to improve the participation of women in science and technology, particularly in IT-related fields. Regional approaches may also be appropriate. Research from elsewhere in the world may be a starting point to understand how to effect change, but it must be noted that although the problem of insufficient women in IT occurs in most countries worldwide, local, cultural and societal explanatory factors differ from country to country (Galpin, 2002). Solutions must, therefore, be assessed as to whether they are appropriate before they are applied.

CONCLUSION

As this article has shown, there is low participation by women as IT professionals in the generation and creation of ICTs. This is caused in part by lower literacy and education rates of women in sub-Saharan Africa compared to men, as well as by societal and other factors that influence the choices of women who do have the opportunities to study beyond the secondary level. As a result, few women are involved in design, development management or policy. The final outcome is that ICTs in sub-Saharan Africa cannot be as successful in their application as they could and should be. This may negatively affect the implementation of ICTs in sub-Saharan Africa for development. The way forward is to increase the participation of women from all backgrounds in IT careers.

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KEY TERMS

Digital Satellite Broadcasting: A means of using satellites to broadcast information to computers via radio using a radio interface card (ALIN, 2002). This technology can be used when there is a lack of telecommunications infrastructure.

FidoNet: A point-to-point and store-and-forward e-mail technology using telephone modems as a means of communicating between computers (Bush, 1992). It played an important role in the start of computer communication in the late 1980s and early 1990s in Africa, with usage predominantly by NGOs and universities (Levey & Young, 2002).

Free/Libre/Open Source Software (FLOSS): Software whose source code is available and, hence, different from proprietary software. FLOSS (also called FOSS) "may be used, copied, and distributed with or without modifications, and … may be offered either with or without a fee" (Waag Society, 2003, para. 3).

High Frequency (HF) Radio E-Mail: A technology for transmitting e-mail using radio modems and a store-and-forward approach (Marshall, 2002), with similarities to FidoNet. It is an appropriate technology when telephone modems cannot be used because of lack of telecommunications infrastructure. Using HF radio allows transmission over long distances but with low bandwidth, hence the necessity to use store-and-forward applications such as e-mail.

Information and Communication Technologies (ICTs): Electronic means of communicating and conveying information, covering media such as radio and television, computer and computer-networking technology and telecommunications.

Information Technology (IT): A term that can be used broadly to cover all computing disciplines, including computer science, IT and software engineering. Computing can also be used as a synonym for IT.

Non-Governmental Organizations (NGOs): An NGO is a non-profit organization focused on particular issues for the public good. It may provide services, lobby government or perform monitoring.

Sub-Saharan Africa: The area of Africa south of the Sahara. In terms of the United Nations definition, this covers all countries on the African continent excluding Algeria, Djibouti, Egypt, Libyan Arab Jamahiriya, Morocco, Somalia, Sudan, and Tunisia, and covers the island states of Comoros, Madagascar, Mauritius, São Tomé and Principe, and Seychelles (UNDP, 2004). All countries in sub-Saharan Africa are developing countries, and 31 are classified as Least Developed Countries by the United Nations because of their very low GDP per capita, low levels of health and education, and economic vulnerability.

Women in the Free/Libre Open Source Software Development

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INTRODUCTION

Free/libre open source software (FLOSS) has become a prominent phenomenon in the ICT field and the wider public domain for the past years. However, according to a FLOSS survey on FLOSS developers in 2002, "women do not play a role in the [FLOSS] development; only 1.1% of the FLOSS sample is female." (Ghosh, Glott, Krieger, & Robles, 2002). In the mainstream research on FLOSS communities, many researchers also overlook different processes of community-building and diverse experiences of members, and presume a stereotyped male-dominated "hacker community" (e.g., Levy, 1984; Raymond, 2001; Himanen, 2001; Thomas, 2002). Moreover, issues around gender inequality are often ignored and/or muted in the pile of FLOSS studies. Female programmers often are rejected ex/implicitly from the software labour market (Levesque & Wilson 2004). The requirements of female users are not respected and consulted either (European Commission, 2001). This feature is opposite to the FLOSS ideal world where users should be equally treated and embraced (op. cit.). While many researchers endeavour to understand the FLOSS development, few found a gender-biased situation problematic. In short, women are almost invisible in current FLOSS-related literature. Most policies targeting at advocating FLOSS are also gender blind.

Thus, this essay highlights the need for increased action to address imbalances between women's and men's access to and participation in the FLOSS development in cultural (e.g., chauvinistic and/or gender-biased languages in discussions on mailing lists or in documentations), economic (e.g., unequal salary levels for women and men), political (e.g., male-dominated advocacy environment) and technical (e.g., unbalanced students gender in technical tutorials) spheres. On the other hand, it also emphasises the powerful potential of FLOSS as a vehicle for advancing gender equality in software expertise. FLOSS helps transport knowledge and experience of software engineering through distributing source code together with the binary code almost without any limit. Many FLOSS licences such as the General Public Licence (GPL) also facilitates the flow of information and knowledge. In other words, if appropriately harnessed, FLOSS stands to meaningfully contribute to and mutually reinforce the advancement of effective, more expedited solutions to bridging the gender digital divide.

In the end, this article points out that while women in more advanced countries have a better chance of upgrading their ICT skills and knowledge through participating in the FLOSS development, the opportunity is less available for women in the developing world. It is worth noting that although the gender issues raised in this article are widespread, they should not be considered as universally indifferent. Regional specificities in gender agenda in software engineering should be addressed distinctly (UNDP/UNIFEM, 2004).

TOWARD A FEMINIST ANALYTICS[1] ON THE GENDER ISSUES IN THE FLOSS DEVELOPMENT

To a degree, the gender problems in the FLOSS development can be seen as an extension of the ongoing gender issues in new-tech service industries and/or software industry (e.g., Mitter & Rowbotham, 1995). These long-term problems mainly include low-level work content, unequal payment, emotional distress from discrimination and prejudice, physical ache from the long working hour in front of the computer, division of labour within the home (child-rearing), essentialist notions of women's roles, sexism, informal networks, prejudice, lack of role models and support, and "glass ceilings." Generally speaking, women within the software industry have to work harder than men in order to get the same respect and conquer the glass-ceiling problem in this patriarchy world (DeBare, 1996).

Although FLOSS has dramatically changed the way software is produced, distributed, supported, and used, and has a visible social impact enabling a richer digital inclusion, most of the gender problems existing in the software industry have been duplicated in the FLOSS field.

A FLOSS *social world* (Lin, 2004) is different from what Turkle (1984) argues: "computer systems [mainly proprietary] represent a closed, controllable microworld—which appeals to more men than women" (Turkle, 1984). It requires a holistic perspective to capture the complexity and dynamics within and across the social world. While the heterogeneity and the contingency in this social world are not yet fully explored, analysis from a feminist perspective is almost absent. Little attention has been paid to the internal differences and to the private arena linked with the FLOSS innovation system. However, this methodological lack has not stopped us from observing the gender problems within the field. Instead, by means of the FLOSS development, some gender problems in ICT become even more apparent.

Additionally, in a world of volunteers, we clearly see that men and a competitive worldview are more present in all forms of media. Many women participating in the FLOSS development are invisible: their labour in fields such as NGOs that help implement and promote FLOSS, documentation translation, book editing, teaching and tutoring (e.g., E-Riders[2]) are less visible than male-dominated coding work. Indeed, FLOSS advocates have not adequately addressed this critique of gender equality. They tend to treat the FLOSS community as a monolithic culture—to pay more attention to differences between and among groups than to differences within them. They are so eager uniting the voices on freedom of information that they give little or no recognition to the fact that FLOSS groups, "like the societies in which they exist (though to a greater or lesser extent), are themselves *gendered*, with substantial differences of power and advantage between men and women" (Okin, 1999).

A number of key dilemmas that hinder women's participation in the FLOSS development can be summarised:

1. **A Lack of "Mentors" and Role Models:** It is true that there is a very low percentage of female participants in the FLOSS social world. However, we should not overlook the importance and possible future of outstanding female figures in the FLOSS field. It is difficult to make the majority of male peers respect these female figures. I am not suggesting that men all look down on women, but it is more difficult for women to be assertive in front of male-dominated audience. The whole way the world is constructed means there are just men at every level, which makes it really hard for women to get their feet in the door. A way of overcoming this is to establish more female figures in the world. While few in the computer world actually know that Ms. Ada Byron is the first programmer in the world, how could we expect people to recognise women's ability?
2. **Discriminated Languages Online and/or Offline (e.g., Phrases in Documentaries):** Many female FLOSS developers have complained the highly unfriendly atmosphere within the social world, online (e.g., mailing lists, IRC) and/or offline (e.g., documentation). For instance, referred to prospective readers, existed FLOSS documentation usually use single sex term, he, rather than she or they. This kind of gender-biased words subtly exclude women from participating in the FLOSS development. While the online languages are in a direct way full of men's jargon, reading the documentation offline does not make a female developer/user feel more included in the field. If women need to be encouraged to participate in FLOSS-related discussions, a sexist or discriminative surrounding is definitely not attractive.
3. **A Lack of Women-Centred View in the FLOSS Development:** The consequence of the lack of female FLOSS developers is that there is a greater amount of female-unfriendly software in the FLOSS system. Some scholars in science and technology studies (STS) have pointed out that technologies are gendered both in their design and use (e.g., Edwards, 1993;

Wajcman, 2004).The social relations of gender within and across the FLOSS social world are reflected in and shaped by the design of FLOSS. And such a lack of women's perspective on software design and use restricts women's participation in the FLOSS development and, in turn, forms the stereotyped fact that women are almost absent in the FLOSS development because they are less adequate in programming or less likely to be advanced computer users. This absence of female developers would also be a loss of the FLOSS development, and result in inequalities in an ICT-based society as a threat to social cohesion and social order.

4. **A Male-Dominated Competitive Worldview:** "[The FLOSS market] is literally a war for the best and brightest. If we don't get there, somebody else will" (Andrew Clark, director of strategy and market intelligence for the venture capital group at IBM—interviewed with C|Net.com on February 14, 2005).
   As Arun and Arun (2001) point out, "The project-based, competitive nature of software development reproduces a masculine culture, which further interacts with the different career patterns of women and social norms and tends to disadvantage women." While languages in a similar tone with Clark's words above repeatedly turn up in the mass media such as advertisements from big computer companies, the male-led competitive worldview is continuously represented and reinforced in the society. Since there are fairly clear disparities of power between the sexes within the FLOSS social world, a gender-imbalanced world is ensued. The more powerful male members are those who are generally in a position to determine and articulate the group's beliefs, practices, and interests. Although not all proposals associated with FLOSS are potentially antifeminist under such conditions, but they somehow duplicate and forward the view that might limit the capacities of women and girls to freely choose lives that they would like to live. It is very alarming that a large amount of perspectives and purposes regarding the FLOSS development is determined by white men. This imbalance might give a distorted world view; it is much better to have views from all people from different social worlds.
5. **No Sympathy from Women Peers:** There are many more spoken or unspoken problems for women to take part in the FLOSS development (e.g., Henson, 2002; Spertus, 1991). However, facing these gender inequalities, many women remain remote and feel no need of tackling these problems. While some women-centred online groups have networked together to address the gender issue in the FLOSS movement, many female programmers still do not share the same view on an ongoing and enlarging gap between men and women software developers. While gender issue in FLOSS is not addressed in most of the literature and also not recognised by female peers, it is difficult to network women to tackle the coherent patriarchal hegemony in the computer world.

HOW CAN FLOSS EMPOWER WOMEN?

Like many other ICTs, FLOSS carries the powerful potential as a vehicle for advancing social equality. It opens up an opportunity for women to learn how to communicate and interact with software designers and speak out what kind of software they want (e.g., file bug report, join the user group and online forum etc.), to have access to source code and fork the software (e.g., to have a female-friendly version of the software), if they are interested and competent.

There are three main ends in current "women movement in the FLOSS community": (1) providing women-friendly software and services; (2) creating a women-friendly environment for developing and using FLOSS; and (3) fostering a gender-balanced ICT innovation system for both competition and collaboration. These three points have close connections with one another. In order to create software that engage and build on women's ideas and visions, we need to create a more women-friendly environment for the purpose of attracting more women to participate in the FLOSS development. Encompassing such a women-centred view of de-

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sign, which usually resembles a more sympathetic and inclusive way of doing, will possibly foster a gender-balanced ICT innovation system that is not only friendly to women but also to various minorities in our society. This system, unlike the current one based on a highly competition-oriented approach, will draw on aptitudes and competences of diverse actors in the FLOSS social world so as to develop a holistic environment which is based on a collaboration-oriented approach.

Networking is important in democratising the access and dissemination of knowledge and establishing a base for a citizenship defined by gender equity. In order to encourage women's participation and also to explain the operation of FLOSS to women, some female developers/users have started to network and form online groups such as, LinuxChix[3], KDE Women[4], Gnurias[5], GenderChangers[6], and Debian-women[7]. They act to dispel the unfriendly wording in documents and in online peer groups, to report this kind of sexist bug reports to other developers, to give online tutorials. These networking and gathering, online or offline, would serve as a base for gender inclusion.

CONCLUSION AND FUTURE RESEARCH

The essay aims to identify the current challenges of gender politics and help formulate strategies and recommendations in order to advance and to empower women in FLOSS. It is anticipated that through conceptualising and documenting the current gender issues in the FLOSS development, it will help enlarge the knowledge base for gender-sensitive policies on ICTs, and propose a women-centred policy towards developing and implementing FLOSS. While FLOSS denotes a new milestone for software development and knowledge making in a broad sense that might alter the social relations of gender, "in this technoscientific advanced era, feminist politics make wider differences in women-machine relationship than the technologies themselves" (Wajcman, 2004). As such, a gender-sensitive agenda for developing FLOSS is urgently needed.

In terms of future research, in order to get a comprehensive overview of the current gender digital divide in the FLOSS social world, more research, both qualitative and quantitative, needs to be conducted. The former would allow us to understand women's experiences and needs better through ethnographical observation, interviews, and focus groups, while the latter would give a fuller picture of general gender problems. Researchers across disciplines are encouraged to analyse FLOSS activities more critically with regard to gender, and to develop conceptual frameworks and methodologies for better understanding and analysing the relationship between FLOSS and gender. Additionally, in encouraging the FLOSS development, governments and organisations should pay extra attention to gender-related issues as well, and take initiatives to include women in the FLOSS development. Holding training workshops for female developers might be a feasible way of bridging the gender digital divide in the FLOSS social world. Other efforts such as design of products and Web sites for women and girls, supporting networks for female professions in FLOSS shall be encouraged.

However, in speaking of implementing and developing FLOSS, most of the cases are centralised or situated in more developed countries. One should bear in mind that there are many undocumented activities that have happened in the developing world. When strengthening the advantages of FLOSS, we should not overlook many problems emerging from implementing FLOSS in developing countries, such as a lack of sufficient training and support. The digital divide shall be considered as a symptom of inequality, not the cause of it. There is a need of understanding what local people really need: water, food, jobs, decent healthcare and sanitation, or software and ICT infrastructure. The gender issue of ICT might be more complex than we thought as well. Female participants very often suffer from hybrid discriminations, both from the male-dominated FLOSS world and the socio-cultural patriarchy in the society. Although virtual groups such Linuxchix Brazil[8] and Linuxchix Africa[9] have started providing women with help on solving problems in implementing Linux, more efforts need to be spent on documenting, analysing and deconstructing the patriarchal hegemony embedded in the whole ICT infrastructure. As such, like many other fields concerned with gendering, this essay is a mere beginning of a feminist accounts about the FLOSS development—an analytic stage on which "we need to place the details contributed by ethnographic research, cultural critiques, sociological surveys, legal scholarship on men and women in their many specific conditions and subjectivities" (Sassen, 1999, p. 2).

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UNDP Bratislava Regional Center and UNIFEM Central and Eastern Europe. (2004). *Bridging the gender digital divide: A report on gender and information communication technologies (ICT) in Central and Eastern Europe and the commonwealth of independent states (CIS).* UNDP/UNIFEM.

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KEY TERMS

Debian GNU/Linux and Debian-Women: Created by the *Debian Project*, is a widely used free software distribution developed through the collaboration of volunteers from around the world. Since its inception, the released system, The Debian Women project, founded in May 2004, seeks to balance and diversify the Debian Project by actively engaging with interested women and encouraging them to become more involved with Debian.

Ethnography: Refers to the qualitative description of human social phenomena, based on months or years of fieldwork. Ethnography may be "holistic," describing a society as a whole, or it may focus on specific problems or situations within a larger social scene.

FLOSS: Free/libre open source software (FLOSS), generically indicates non-proprietary software that allows users to have freedom to run, copy, distribute, study, change and improve the software.

Focus Group: A focus group is a form of qualitative research in which a group of people are asked about their attitude towards a product, concept, advertisement, idea, or packaging. Questions are asked in an interactive group setting where participants are free to talk with other group members.

GPL: General Public License (GPL) is a free software licence that guarantees the freedom of users to share and change free software. It has been the most popular free software license since its creation in 1991 by Richard Stallman.

Hegemony: Is the dominance of one group over other groups, with or without the threat of force, to the extent that, for instance, the dominant party can dictate the terms of trade to its advantage; or more broadly, that cultural perspectives become skewed to favor the dominant group.

KDE(K Desktop Environment): A free desktop environment and development platform built with Trolltech's Qt toolkit. It runs on most Unix® and Unix®-like systems, such as Linux, BSD, and Solaris.

ENDNOTES

1. By "feminism" I mean the belief that women should not be disadvantaged by their sex, that the moral equality of men and women should be endorsed, and that all forms of oppression should be demolished.
2. http://www.eriders.org
3. http://www.linuxchix.org/
4. http://women.kde.org/
5. http://www.gnurias.org.br/
6. http://www.genderchangers.org/
7. http://women.alioth.debian.org/
8. http://www.linuxchix.org.br
9. http://www.africalinuxchix.org

Women Returners in the UK IT Industry

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INTRODUCTION

IT is a sector that incorporates the newest industries, consisting mainly of young firms and relatively freshly constituted forms of working practices. Despite this, several studies exist to-date that show that opportunities are limited for those women who aspire to have a career in IT. Recent research in the UK has revealed that between 1999 and 2003 the proportion of women in the UK IT workforce fell by almost 50%, from 21% to 12.5%, following steady growth (Platman & Taylor, 2004). The focus of the article is to examine a specific group of female IT staff: women returners. The work presented here explores the factors that often constrain women returners to the IT industry and discusses the findings in relation to the characteristics of the industry; it is part of a bigger study that looks at advancing women in high-tech industries[1]. If women are not found in positions of influence in the IT industry, one of the most growing industries, then what image is being given to prospective students, their parents and careers advisers? What influence will women have on the future developments within the discipline, hence on the industry itself?

BACKGROUND: WOMEN RETURNERS IN IT

IT has been a fast growing industry with an impact on most organizations, large and small, traditional and emergent and vast employment opportunities. Indeed, computing work is characterised by growth in demand but it is also simultaneously characterised by obsolescence of skills (Wright & Jacobs, 1995). That means that computer workers have to go through extensive training most of the time in their career if they want to stay up-to-date with the frequent changes in software, hardware and programming. Also the sector, although a comparatively new one, has been characterised as predominantly white, middle-class and male-dominated (Panteli, Stack, & Ramsay, 1999b). This indicates that men hold high profile posts such as developers and managers of systems whereas women are more likely to be seen as the users of those systems. This phenomenon has also been illustrated by Platman and Taylor (2004) in their recent report. They clearly stated that the UK IT industry is male dominated and full-time, which designates that there are substantial obstacles for women working in IT.

Accordingly, despite the industry growth and increasing job opportunities, several research studies exist to-date that draw attention to the gender inequality in IT employment (Panteli, Stack, Atkinson, & Ramsay, 1999a; Panteli et al., 1999b; Roldan, Soe, & Yakura, 2004). For example, women in IT are increasingly concentrated in areas of work that are low in status, power, and rewards. As women move up the career hierarchy, their representation shrinks, thus the proportion of women in this high tech sector remains underrepresented in top management posts and in key technical jobs (Panteli et al., 1999a; Roldan et al., 2004).

For the purpose of this chapter, we take a focus on a particular group of female employees: women who seek re-entry following a career break, thus women returners. Most of the academic studies on women returners have focused on women's choices and career orientations (Doorewaard, Hendrickx, & Verschuren, 2004) as well as on trying to identify either the demands of women for returning to work or their fears and their differences compared to men (Healy, 2004; Healy & Kraithman, 1991; Shaw, Taylor, & Harris, 1999). A major difference for example between men and women is that women shape their working lives around the competing domestic demands, (e.g., childbirth, household etc.). They link and adjust their work with the different phases their life is going through.

A career break is a period of time where an employee is not working for very specific reasons (Institute of Physics, 2004). The length of career break may vary according to the needs it attempts to cover; for example a maternity leave can be from 26 weeks and over, and it is often the main reason for taking a career break (Rothwell, 1980). Another reason for a career break includes the need to study (e.g., for a further qualification or to follow one's partner on sabbatical leave or on a foreign assignment) (Warrior, 1997). Research has also identified a pattern for women's re-entry to the labour force. According to Rothwell (1980), this pattern includes an "in-and-out" period while children are young, followed by a part-time period, and eventually a return to full-time employment when the children grow up. Rothwell (1980) explained that this pattern depends on women's job ambitions, on family's financial conditions and on the local labour market.

Another barrier on women's return to work is the lack of affordable, accessible, quality childcare. Paul, Taylor, and Duncan (2002) found that 18% of mothers of pre-school children who are working part-time reported that they are prevented from working longer hours by having to look after children, compared with 25% for part-time mothers with school, but not pre-school, children. This proportion according to the authors shows that they could work longer if suitable childcare was available. Other studies have showed that many women with caretaking responsibilities at home tend to accept relatively low-skilled part-time jobs (Doorewaard et al., 2004; Houston & Marks, 2003).

Shackleton and Simm (1998) argued that women returners require training in both "hard" and "soft" skills. Generally, such training takes a focus on the updating of existing skills, confidence building, and training in new technology. Work experience may also contribute towards raising the self-esteem levels of those wishing to reenter the labour market, who often feel that they lack the necessary work-related skills to compete. In particular, in the field of IT the rapid change in technological advancements and IT applications in the recent years has affected a great area in an organization's life including personnel requirements and training. Up-to-date training appears to be an imperative for women returners in particular in coordination with more management support so they would be able to return to their previous job.

EMPIRICAL STUDY

The study presented here, which is part of a bigger project on advancing women in the high-tech industries (i.e., ITEC), was carried out using qualitative information based on in-depth interviews with women returners. These were undertaken during the period December 2004 and January 2005. In particular, women who have returned to work after a career break, are currently on a career break, or are planning one, have been invited to participate in our study. The majority of the interviews (84%) were conducted over the telephone due to the geographical dispersion of the interviewees whilst the rest were face-to-face interviews.

Though the interview questions were pre-determined to ensure that the necessary information was collected, these remained open-ended in an attempt to record the views and perceptions of the respondents. This allowed questions and issues that were revealed during the interview to be explored further. Interviews lasted from 30 to 40 minutes and were tape-recorded when the interviewees granted permission. The interview data was transcribed selectively. The analytical approach adopted was exploratory as the aim of this report is to explore the main issues around women's employment in the IT sector and in particular women returners. A simple way to explore data at this stage of the project is to recast it in a way that counts the frequency (i.e., the number of times that certain things happen), or to find ways of displaying that information.

RESULTS

Our interviewees were categorized into three groups based on their employment status:

- Women currently on a career break (WCB)—16.7% of the participants
- Women who have had a career break but did not return to IT (WnR)—16.7%
- Women who have had a career break and returned either to their previous job or to another job within the ITEC sector (WR)—66.6%

The main difference between the WnR and WR groups was in the duration of their career break. In the first case, the career break was 1-15 years whereas in the second case their break lasted only 1-2 years. For the women belonging to the WnR group the long time they spent upbringing their family has clearly negatively affected their return to the industry.

In brief, the study has shown that the primary reason for a career break was maternity leave. This has implications on their needs as it will be discussed below, when they decide to return to employment and resume their career. The participants in the study were also found to hold a range of qualifications, from vocational training to PhD. It is very interesting to mention the case of women who have not returned to IT (WnR); although these mainly have high-level academic qualifications they have not been able to find a job in accordance with their qualifications. Furthermore, despite the fact that women in the WnR group used to have highly responsible jobs, they are found in jobs of low status and low payment outside the industry.

Moreover, the women who are currently on a career break have shown a preference for part-time jobs despite their previous successful full-time career, whilst the group of women who have not returned to IT and consequently unable to resume their career, would like to find a full-time job or a "proper" job as characteristically one of them stated.

In their UK-based study, Platman and Taylor (2004) found that the lack of part-time work available for women in the IT profession is one of the main reasons why they are discouraged from the profession. The report also showed that the part-time workers in the UK, at 5.3% are lower than the proportion in Germany (8.6%) and the Netherlands (16%). In particular, only the 16.9% of female IT professionals work part-time in the UK, compared with 37% in the Netherlands and 19% in Germany.

The lack of part-time schemes is not the only hurdle however for women in the UK IT industry. As it was argued in Panteli, Stack, and Ramsey (2001), "the offer of part-time work is also likely to mean a sharp reduction in opportunities for advancement. At the least these factors will delay women's advance; or they may permanently damage their prospects in cultures dominated by masculine conceptions of appropriate career paths and staging" (p. 10). It appears therefore that whereas the availability of a part-time scheme may work to the detriment of women and their career development, the lack of a part-time scheme is also a serious hurdle to women's retention in computing work following a career break.

In addition to the above, the current research study has identified the major factors that constrain women to return to IT after a career break and resume their career. Women who are currently on a career break or have returned to work within only 2 years of their career break are concerned about childcare arrangements and have a preference for flexi-time and part-time schemes, than women who have been on a career break until their children have grown up. These women can more easily return to full time employment, are more in need of re-training, and clearly ask for changes in employers' attitudes. Interestingly, however, all groups including those women who have only stayed for a limited time away from the industry indicated that they experienced loss of confidence during the re-entry process. Women in the WR group explained that his was a result of reasons such as changing from full-time to part-time employment, the industry changes very quickly as well as that they might have stayed long enough out of work which makes them feel less competent.

Overall, the rapid changes that the sector experiences contributes to skills obsolesces and loss of confidence and unless opportunities are available for retraining women either do not return to IT or return to lower-status jobs with low pay. Further obstacles include the inflexibility of the sector to offer part-time jobs and other flexible working patterns.

FUTURE TRENDS

In the light of the literature review and empirical findings, one can tentatively conclude that women in this high-tech field have to overcome more constraints than women employees in any other form of industry. It is also evident that the number of women remaining in the IT sector is decreasing often due to the unfavourable working conditions and consequently the limited career prospects. The image of the industry consists of a competitive, male-dominated along with the fact that this is a fast-growing and continuously changing field; these will remain the main barriers for women's recruitment, retention and advancement in IT.

In this study we focused on women's position in the particular field of IT and more generally on what hinders their return to work after they have had a career break. However, there is little progress connecting these outcomes with the factors that enable women to return to work by studying and comparing women's perceptions on the topic. Future research will seek to provide an opportunity to develop a more carefully grounded link between what deters and what encourages women to return according to their insights and experiences. In addition, further research and analysis is considered necessary in order to evaluate the schemes that already exist to support women returners as well as to recommend additional practices and actions to enhance the current conditions.

CONCLUSION

In this article, we examined the career prospects for women in the UK who seek re-entry to IT following a career break. The chapter is primarily based on women's own views and experiences. Using empirical data, we found evidence of barriers and limited opportunities for those women who want to return to their IT job after a career break. The study has shown that women returners are not a homogeneous group and that the length of their career break appears to play a key role in the re-entry process. Overall, career breaks appear to counteract career development due to the lack of support mechanisms such as flexible working, part-time working, and insufficient training.

It is well documented that the IT sector has so-far failed to show the appropriate commitment towards gender inclusion. Lack of well-established gender strategies within the sector do not allow the implementation of policies favourable to women's employment such as part-time working. Our study on women returners in IT reinforces these views.

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KEY TERMS

Career Break: A career break is a period of time where an employee is not working for very specific reasons.

ITEC: Information technology, electronics and communication.

Women Returners: Women who seek re-entry to the labor force following a career break.

ENDNOTE

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Women, Hi-Tech, and the Family-Career Conflict

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INTRODUCTION

This article focuses on female software engineers in the Israeli hi-tech industry. We describe findings of our research that was based on in-depth interviews with 17 female software engineers from four organizations of different kinds and sizes.

BACKGROUND

Software is developed by human beings, usually working in teams. Indeed, the professional literature addresses software teamwork, roles in software teams, and other related topics. For example, van Vliet (2000) discusses general principles for team organization, Hughes and Cotterell (2002) dedicate a full chapter of their book to people management and software team organization, and Humphrey (2000) describes a full software development process from a team perspective.

At the same time, however, our literature review indicates that the role of women in software teams has not been researched extensively. Moreover, although the underrepresentation of women in the IT field in general and as software engineers in particular is well documented (Camp, 1997, 2002; Hazzan & Levy, in press), only few studies deal specifically with women working in the software industry (Sosa, 2005; Turner, Bernt, & Pedora, 2002). Continuing this line, the present article focuses on women participation in software teams.

Women in the Information-Technology and Software Industry

The "shrinking pipeline" (Camp, 1997) describes a phenomenon related to women in computer science, according to which, in addition to the pipeline shrinking from high school to graduate school, the pipeline has been shrinking during the last 20 years at the bachelor's level. For example, in the United States, women currently receive less than 20% of all bachelor's degrees in computer science, compared with 37% in 1984. Camp argues that "[s]ince the number of women at the bachelor's level affects the number of women at levels higher in the pipeline and in the job market, these facts are of great concern" (p. 104). Following Camp's 1997 article, this topic received extensive attention (Camp, 2002; Margolis & Fisher, 2002).

Women in the Israeli Software Industry

Our article focuses on Israeli female software engineers. Thus, characteristics of the Israeli software industry are considered in our study as well. For this purpose, we will first briefly describe the Israeli hi-tech industry.[1]

Israel is a very small country with a population of about 7 million people. Still, at its hi-tech economic peak during the 1990s, Israel was one of the world's leading centers of technology start-ups and innovations. Despite its small population, Israel had at that time about 3,000 start-ups,[2] and it came in third (after the USA and Canada) on the list of countries with the highest number of companies listed on NASDAQ.

This blossoming is explained by two main factors. The first is the national security and military needs that led to the development of cutting-edge technologies. Since its establishment in 1948, Israel has been forced to invest huge budgets and efforts to maintain its military advantage in order to survive. In particular, designated army units exist that specialize in technological innovations. As it turns out, many of Israeli's hi-tech entrepreneurs started their careers in the Israeli army.

The second factor that explains the success of the Israeli hi-tech industry in the 1990s is the massive immigration wave of Russian engineers from the former Soviet Union during the 1990-to-2000 decade. This addition of engineers to the Israeli population led Israel to have the highest number of engineers per capita in the world.[3]

One comprehensive, quantitative research on women in the Israeli hi-tech fields was conducted by Frenkel and Izraeli (in press). Among other things, they found that, on average, incomes of mothers who work in the Israeli hi-tech industry are higher than those of women who also work in this industry but are not mothers, mothers in this industry are more satisfied with their work than their nonmother counterparts, and the price that mothers in this industry pay is expressed mainly by higher levels of stress and the lack of leisure time. However, they concluded that the family-career combination is more rewarding than each one of them alone. It should be emphasized that this research was a quantitative study. The women who participated in it were approached through the Internet, and it included only those women who were still working in the hi-tech industry.

Our research findings, presented in the continuation of the article, show that this picture might be correct for those mothers who are still in the hi-tech industry (i.e., did not leave the hi-tech industry after they became mothers). As we shall see, the women who did leave the hi-tech industry after they became mothers (and therefore did not take part in the above-mentioned research) reveal another aspect of the picture: They left the hi-tech industry in their attempt to solve the family-career conflict.

Another major finding of Frenkel and Izraeli's (in press) research indicates a connection between the division of housework between the two spouses and the woman's success. Specifically, women who share the housework with their spouses earn more and are more satisfied with their jobs than women who "own" the housework. Our research refines this finding. Specifically, it indicates a link between the spouse's occupation, the ability of the two spouses to share the housework, and the female software engineer's course of promotion.

By using a qualitative research approach, as described in the next section, our research enables one to understand subtle details that clarify and shed additional light on the above-mentioned numerical data.

RESEARCH METHOD

Our qualitative research used in-depth interviews for data collection and inductive data analysis. Specifically, over the course of 6 months, between April and October 2004, we interviewed 17 female software engineers who work (or worked) at four hi-tech companies of different areas in the Israeli software industry. The women interviewed were very highly educated (three hold PhDs, six have MScs, and eight have BScs) and were at different stages of life: Two women were unmarried, three had no children, and the rest were married (to their first husband) with 2 to 4 children.

Each interview addressed the following main topics by referring to the following issues and additional relevant subjects that emerged during the interview.

- **Past:** How she became a software engineer
- **Present:**
  - **Current Present:** Daily schedule, tasks she is currently working on, what she might be doing if she were not talking to us at the moment
  - **Continuous Present:** Projects she is part of and her role in these projects, her work style, challenges in her work (professional, personal, social, cultural), conflicts she faces and how she bridges them, how she sees an ideal software development environment
- **Future:** How she envisions her future in the field
- **Teamwork:**
  - **Her Team:** Description of the team, the way it functions and her role in it, how she believes others perceive her, who decides on roles and work assignments in her team and according to what criteria

- **Other Teams She is Familiar with:** Their functionality, tasks they have succeeded or failed in

In order to listen to the women's voices, we let the women lead the interview to the extent that they found relevant. Indeed, this nature of the interview enabled us to open up to new directions and point of views suggested by the interviewees (Harding, 2004).

We restricted the interview to 1 hour, even in cases in which we could have continued. Our message was that we value the time the female software engineers dedicated to the interview. We always invited each interviewee to share further thoughts with us, should she find it appropriate.

MAIN THRUST OF THE ARTICLE

Our data analysis reveals that the perspectives of the Israeli female software engineers are best described in relation to the stages in life and factors that influence their career paths. Thus, we organize this section around six typical profiles that emerge from the analysis of the interviews. For each profile, we describe the factors that influence a particular life story and how the interviewees cope with these factors.

Needless to say, these profiles do not necessarily encompass all female software engineers. However, since our interviewees come from different organizations and are at different stages in life, we believe that the profiles can be regarded as representative of Israeli women software engineers with similar characteristics.

Profile A: "I Guess there are Some Gender-Related Issues Here"

This profile characterizes young women who are not mothers. The typical Profile A software engineer is either a single or just-married woman. She is starting to develop her hi-tech career and seems to be pleased about her job. She is, however, concerned about how the future will look like with children. While some Profile A women consider their spouses to be partners in caring for the children, other Profile A software engineers assume, even at this early stage of their adult life, that they will bear all responsibility related to child raising. In either case, the woman suspects that her spouse's occupation will influence her career. Often, she derives her model from the way she views her mother.

As has emerged from our interviews, Profile A software engineers devote a considerable amount of attention to social issues, such as who goes with whom for lunch and who lives where. As we shall see in the other profiles, this type of concern is not evident in interviews with women who are mothers. Instead of social-related topics, issues such as time management and factors influencing promotion assume a more central place in their set of concerns.

Profile B: "My Spouse's Work Enables Me to Develop a Career"

Having one child usually enables the female software engineer to go on with her professional life as before. Neither she nor her spouse must give up her or his career. The actual family-career conflict emerges when the second child is born. It seems that in many cases, the way in which this conflict is solved is determined almost solely by the spouse's occupation. If the woman's spouse does not work in the hi-tech sector, it is most likely that she will continue to develop her career as she envisioned it. Profile B addresses this case. If the spouse also works in the hi-tech sector, then it is most likely that she belongs to one of the profiles described next.

Profile C: "It is My Decision to Give Up My Career, Even though I Could Succeed"

This profile illustrates how the fact that the spouse also works in the hi-tech industry has a direct influence on the woman's career. Specifically, this profile describes cases in which female software engineers struggle with the family-career conflict (Ahuja, 2002) and the family prevails. A typical line of thought that characterizes Profile C software engineers is, "I'll do the maximum possible within the restricted time I have at work and will be aware of the fact that I could achieve more. But it was my decision to give up my career." In fact, some of the women explicitly say that they are not prepared to transfer the homemaking responsibilities to their husbands. Declaring that it is their decision to give up their career, no matter what the real reason is, naturally makes the dilemma easier.

Profile D: "I'll Go on Struggling with this Lifestyle"

This profile describes a female software engineer whose husband works in hi-tech, and who has decided, despite the fact that she faces the family-career conflict, to go on struggling with the long-hours system that characterizes the hi-tech industry. As it turns out, no matter how much she struggles and how great her dedication and willingness to juggle family and career, it is to no avail and, according to our interviewees, her promotion, in many cases, is still blocked in different ways.

Profile D women were very emotional throughout the interview. Furthermore, they expressed a very clear approach, trying hard to justify it during the interview. On the surface, it seems that they belong to Profile C since they sometimes express a desire to give up. However, they do not express the compromised approach expressed by Profile C women. The main difference between the two profiles lies in the fact that Profile C software engineers gave their careers up a priori, while Profile D software engineers often have a successful career and their struggle with the conflict is expressed after they having gained some achievements beyond being a software team member. Accordingly, the focus in this case is placed on the factors that prevent their promotions from happening faster.

Profile E: "I'll Leave this Job When I Become a Mother"

This profile describes a woman whose husband also works in the hi-tech industry, and who thinks, "I know what it means to juggle career and family. Therefore, the moment I become a mother, instead of struggling, I will immediately leave the hi-tech industry and will live a peaceful life." Such a woman is usually aware of the fact that mothers in her company have a hard time struggling with the family-career conflict. Unlike women of the next and last profile (Profile F), Profile E women refuse to be part of this struggle and choose to leave their hi-tech jobs as soon as motherhood becomes reality for them.

Profile F: "I'll Fight a Little and then Leave"

This profile represents women in different stages of leaving the hi-tech industry: Some still work in the industry but with a clear feeling that they are about to leave it, others are in the midst of a leaving process, and yet others have already left. In all cases, the husbands are hi-tech employees and are not involved at all in the home-maintenance chores. This, however, is not the only reason the women give for their desire to leave the hi-tech industry. All of the Profile F women express a desire to change their careers and are happy that their husbands' relatively high incomes enable them to leave this demanding system. Furthermore, some of them declare that many of their colleagues, both men and women, would probably prefer to leave the hi-tech work environment, but do not have the courage to forfeit power and income.

Main Observations

Based on the above analysis, we now highlight three observations.

First, it is not gender in itself that constitutes the family-career conflict; rather, it is motherhood. In other words, as long as a woman is single or married without children, the unlimited-hours barrier does not exist; the moment a woman becomes a mother, barriers are set.

Second, the ability to develop a career in the hi-tech industry is determined almost entirely by the spouse's occupation. If he works in the hi-tech industry, one of the spouses must make a decision to waive his or her career in order to maintain the home; in all cases encountered in our interviews, it was the mother. In other words, one of the main factors that influences female software engineers' courses of promotion in the Israeli hi-tech industry is their ability to work unlimited hours. This ability is directly connected to their spouse's occupation. On the one hand, if he works in hi-tech, it is most likely that she will be the one in charge of maintaining the home, and her ability to dedicate the required long work hours will suffer. Consequently, she will not be given responsibilities and will not attain management roles. On the other hand, if her husband does not work in the hi-tech industry, she will be able to dedicate more time to her work, will be given responsibilities, and will be promoted appropriately.

Third, as it turns out, even if in practice women dedicate to their work the same number of hours (or more) as do their male colleagues, it might be insufficient. More specifically, some of the women we interviewed try to compensate for their need to leave work early (due to their responsibilities at home) by arriving at work earlier than most of their colleagues. Such attempts, however, do not help them shatter the image of not being totally dedicated to work. More explicitly, if one is not available 100% of the time, his or her dedication to work is not perceived as high. As a consequence, this perceived lower evaluation prevents the female software engineers from being given management responsibilities, although their actual workload is the same as that of other software engineers. This becomes extreme even if the woman leaves early only twice a week. Once again, the ability to work unlimited hours is determined by the spouse's occupation. As stated above, if the spouse does not work in hi-tech, there is no problem; if he does, the one to give up a career, at least in the case of the women we interviewed, is the woman.

FUTURE TRENDS

In this section, we question whether the phenomena described in this article are typical to the Israeli hi-tech industry, or whether they also characterize the hi-tech industry in other places in the world. Some of the interviewees, who were relocated to the United States for several years, addressed this issue in their interviews, comparing the atmosphere and working environment in the two countries: the United States and Israel.

We present two of the differences mentioned. First mentioned was the fact that women in the United States start their careers earlier in life since they do not serve in the army, which in Israel is compulsory for men and women. Therefore, female software engineers in the United States usually start developing a career before they become mothers, and even postpone motherhood in order to make the most of the work world before they become mothers, predicting that they will want to stay at home with their children. Naturally, their future career is determined by this fact. Second, according to our interviewees, it is more acceptable in the United States to leave work at 5:00 p.m. (for both men and women). As a result, the career-family conflict described in this article is reduced.

CONCLUSION

In this article, we suggested a framework that describes the course of life of women in the Israeli hi-tech industry from their own perspective. Based on interviews with 17 female software engineers working in Israeli software organizations, we identified six representative profiles. In addition, we presented three main observations that highlight the career-family conflict. We hope that the framework provides the readers of this article with an inside look through which to ponder gender issues in the hi-tech industry.

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KEY TERMS

Shrinking Pipeline: The pipeline represents the ratio of women involved in computer science from high school to graduate school. The pipeline shrinkage problem focuses on several critical junctions: from high school to the bachelor's level, and at the seniority levels both in academia and in industry.

Software Engineering: The application of engineering principles to the construction of software products. Specifically, principles of computer science and mathematics are applied in the development, operation, and maintenance of software. Software engineering addresses not only the technical aspects of building software systems, but also social, management, and cognitive topics.

ENDNOTES

1. This description is based largely on Tomayko and Hazzan (2004).
2. http://www.ite.poly.edu/htmls/role_israel0110.htm
3. http://www.smartcodecorp.com/about_us/israel_profile.asp

Women, Mathematics, and Computing[1]

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INTRODUCTION

In 1963, Betty Friedan wrote these gloomy words:

The problem lay buried, unspoken, for many years in the minds of American women. ... Each suburban wife struggled with it alone. As she made the beds, shopped for groceries, matched slipcover material, ate peanut butter sandwiches with her children, chauffeured Cub Scouts and Brownies, lay beside her husband at night – she was afraid to ask even of herself the silent question—"Is this all?"

The passage, of course, is from the *The Feminine Mystique* (Friedan, 1983, p. 15). Though it took another decade for the discontent that Friedan described to solidify into a political movement, even in 1963 women were doing more than making peanut butter sandwiches. They also earned 41% of bachelor's degrees. By 1995, the number of degrees conferred had nearly tripled. The fraction going to women more than kept pace, at almost 55%. Put another way, women's share of bachelor's degrees increased by 25% since Betty Friedan first noticed the isolation of housewives. Consider two more sets of numbers: In 1965, 478 women graduated from medical school. These 478 women accounted for only 6.5% of the new physicians. Law was even less hospitable. Only 404 women, or just 3% of the total, received law degrees in 1965. By 1996, however, almost 39% of medical degrees and 43% of law degrees were going to women (Anderson, 1997).

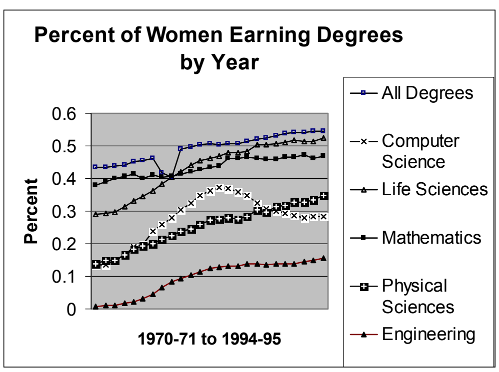
If so many women are studying medicine and law, why are so few studying computer science? That's a good question, and one that has been getting a lot of attention. A search of an important index of computing literature, the *ACM Digital Portal* (ACM, 2005a), using the key words "women" and "computer," produced 2,223 hits. Of the first 200, most are about the underrepresentation of women in information technology. Judging by the volume of research, what we can do to increase the numbers of women studying computer science remains an open question.

While most investigators fall on one side or the other of the essentialist/social constructivist divide (Trauth, Quesenberry & Morgan, 2005), this article sidesteps the issue altogether in favor of offering a testable hypothesis: Girls and young women would be drawn to degree programs in computer science in greater numbers if the field were structured with the precision of mathematics. How we arrived at this hypothesis requires a look at the number of women earning degrees in computer science historically and in relation to other apparently similar fields.

BACKGROUND

In 1997, *The Communications of the ACM* published an article titled "The Incredible Shrinking Pipeline" (Camp, 1997). The article points out that the fraction of computer science degrees going to women decreased from 1986 to 1994. This bucks the trend of women entering male-dominated professions in increasing numbers. The graph below shows the percent of women earning degrees in various scientific disciplines between 1970-'71 and 1994-'95 (National Center for Educational Statistics, 1997).

Figure 1.



If you did not look at the data over time, you would be justified in concluding that the 13% or so engineering degrees going to women represents a terrible social injustice. Yet the most striking feature of the degrees conferred in engineering and the physical and life sciences is how closely their curves match that of all degrees conferred to women. Stated another way, the fraction of degrees in engineering and the sciences going to women have increased enormously in a single generation. It has, in fact, out-paced the fraction of all degrees going to women. The curves for engineering and the life sciences both have that nice S shape that economists use to describe product acceptance. When a new kind of product comes to market, acceptance is initially slow. When the price comes down and the technology improves, it accelerates. Acceptance finally flattens out as the market becomes saturated. This appears to be exactly what has happened in engineering. Following the growth of the women's movement in the early 1970s, women slowly began to account for a larger share of degrees conferred. By the early 1980s, the fraction grew more rapidly, and then, by the 1990s, the rate of growth began to slow. A parallel situation has occurred in the life sciences, but at a much higher fraction. Women now earn more than 50% of undergraduate degrees in biology.

Computer science is the anomaly. Rapid growth in the mid-1980s was followed by a sharp decline. The fraction of women graduating in computer science flattens out in the 1990s. What is going on here? A study of German women noticed that the sharp increase in the number of degrees in computer science going to women followed the commercial introduction of the microcomputer in the early 1980s (Oechtering, 1993). This is a crucial observation. In a very few years, computers went from something most people were only vaguely aware of to a consumer product. What the graph does not tell you is that great numbers of men also followed the allure of computing in the early and mid-1980s—numbers that declined by the end of the decade.

Despite many earnest attempts to explain why women do not find computer science as appealing as young men (e.g., Bucciarelli,1997; Wright, 1994), it is important to point out that computer science is not like the other areas we have been considering. Unlike physics, chemistry, mathematics and electrical engineering, there is not an agreed-upon body of knowledge that defines the field. An important textbook in artificial intelligence, for instance, has grown three-fold in 10 years. A common programming language used to teach introductory computing barely existed a decade ago. Noam Chomsky has suggested that the maturity of a scientific discipline is inversely proportional to the amount of material that forms its core. By this measure, computer science is far less mature than other scientific and engineering disciplines.

Many studies have shown that girls are consistently less confident about their abilities in mathematics and science than are boys, even when their test scores show them to be more able (e.g., Mittelberg & Lev-Ari, 1999). Other studies attribute the shortage of women to lack of confidence along with the perception that computing is a male domain (Moorman & Johnson, 2003). Unfortunately, computer science, at least as presently constituted, requires a good bit of confidence. The kinds of problems presented to computer science majors tend to be open-ended. Unlike mathematics, the answers are not in the back of the book—even for introductory courses. There is often not a single best way to come up with a solution and, indeed, the solutions themselves, even for trivial problems, have a stunning complexity to them. The tools that students use to solve these problems tend to be vastly more complex than the problems themselves. The reason for this is that the tools were designed for industrial-scale software development. The move over the last decade to object-oriented languages has only exacerbated an existing problem (Hsia, Simpson, Smith, & Cartwright, 2005). A typical lab assignment to write a program in the C++ or Java language will require that the student have a working knowledge of an operating system, graphical user interface, text editor, debugger and the programming language itself.

One surrogate for complexity is the size of textbooks. Kernighan and Ritchie's classic, *The C Programming Language* (1978) is 228 pages long. The first program in the book, the famous "Hello world," appears on page 6. Deitel, Deitel, Lipari, and Yaeger's (2004) *Visual C++ .NET: How to Program,* on the other hand, weighs in at a hefty four pounds and runs to 1,319 pages. Students have to wade through 52 pages before they reach the book's program equivalent to "Hello, world." The key to successful mastery in this environment is the willingness to tinker and the confidence to press forward with a set of tools that one only partially understands. Although we exhort our students to design a solution before they begin to enter it at the keyboard, in fact, the ready availability of computers has encouraged students to develop a trial-and-error attitude to their work. Those students willing to spend night after night at a computer screen acquire the kind of informal knowledge necessary to write successful programs. This is a world that will welcome only very self-assured young women.

MATHEMATICS, ENGINEERING, AND TINKERING

Recall Chomsky's observation that the most mature disciplines are the most tightly defined. What discipline can boast the tightness and precision of mathematics? As it happens, many reasonable people have attributed at least some of the shortage of women in science and computing as well as the less-than-positive attitudes toward computers to so-called math anxiety among girls (e.g., Chang, 2002; Jennings & Onwuegbuzie, 2001; Mark, 1993). One study says that "The culture of engineering places particular stress on the importance o f mathematical ability. Math is both the most complicated and the purest form of mental activity. It is also the most 'masculine' of subjects" (McIlwee & Robinson, 1992, p. 19, referring to Hacker, 1981). At first glance, the heavier reliance on mathematics might appear to explain why women avoid physics and electrical engineering while embracing biology and oceanography. But this explanation is insufficient for the simple reason that women receive nearly half of the undergraduate degrees in mathematics itself and were receiving almost 40% of them well before the women's movement became a mass phenomenon.

Here, then, is a hypothesis. What if the precision of mathematics is exactly what has appealed to women for so long? And what if the messiness of computing is what has put them off? So far, so good, but we still have to account for electrical engineering and physics. These have a smaller fraction of women than computer science, but are well defined and rely heavily on sophisticated mathematics. What is it about physics and electrical engineering that women find unattractive? The answer is really quite simple. Students drawn to engineering and physics like to tinker with gadgets (e.g., Crawford, Wood, Fowler, & Norell, 1994). That paper describes a grade school curriculum designed to encourage young engineers. It relieves heavily upon "levers, wheels, axles, cams, pulleys, forms of energy to create motion, etc." (p. 173). McIlwee and Robinson (1992) report that 57% of male engineers surveyed chose the field because they like to tinker. Only 16% of women surveyed chose engineering for this reason. It should come as no surprise that the men associated with the microcomputer – Bill Gates, Paul Allen, Jobs and Wozniak—all got their start as tinkerers. And as all parents know but are hard-pressed to explain, their infant sons are drawn to trucks more readily than their infant daughters (Serbin, Poulin-Dubois, Colburne, Sen, & Eichstedt, 2001).

MICROCOMPUTERS, A PROBLEM WITH COMPUTER SCIENCE EDUCATION

Here we find a convergence with computer science and, finally, an explanation for the steep rise in the number of women in the field following the introduction of the microcomputer and its drop a few years later. The development of the microcomputer changed computing enormously. In 1971, a small number of computer science departments awarded fewer than 2,400 degrees. Most people who worked in the thriving data processing industry had received their training in the military, for-profit vocational schools or on the job. By 1986, that number had jumped to nearly 42,000, including almost 15,000 women. Clearly, the microcomputer played a large part in the growth of the academic discipline of computing. Like the dot-com boom, the growth could not be maintained. If the production of computer science degrees had continued to climb at the rate it climbed between 1975 and 1985, by 2001 every American would have had a Bachelor of Science degree in the field. In fact, the number of degrees awarded began to drop sharply in 1987.

We know why both men and women entered IT in the 1980s. Why did the numbers drop by the late 1980s? We cannot really know the answer to this, of course, short of polling those who did not major in computer science during that period; but we can guess. Computer science is hard. What's more, it is not a real profession. There are no licensing barriers to entry, an issue that has been hotly debated in computing literature for at least two decades (ACM, 2005b).Until computing societies agree on licensing and convince state legislatures to go along, students need not earn a degree in computer science to work in the field.

These things are equally true for women, of course, but the tinker factor is an additional burden. Before the mid-1980s and the mass availability of microcomputers, programmers could almost ignore hardware. This article's author wrote programs for a large manufacturer of mainframe computers in the early 1980s without ever having seen the computer he was working on, nor, for that matter, the printer that produced the green bar paper delivered to his cubicle every two hours. There was tinkering going on in those days too, of course. But it was all software tinkering; only computer operators touched the machine. The micro changed all that. Suddenly, those young men who had spent their adolescence installing exotic operating systems and swapping memory chips were in great demand. By adding hardware tinkering to the supposed repertoire of skills necessary to program, the microcomputer reinforced the male-dominated culture of IT (for an account of this very male atmosphere, see De Palma, 2005).

CONCLUSION

Until the day when baby girls like gadgets as much as baby boys, let us look to mathematics itself to see what we can do about attracting young women to computer science. Well before other fields welcomed women, a significant fraction of degrees in mathematics were going to females. Let us assume that the mathematicians have been on the right track all along. A testable hypothesis presents itself. If we make computer science education more like mathematics education, we will make computer science more appealing to women. Computer science grew out of mathematics. How do we get back to basics?

First, teach girls who like to manipulate symbols how to program. Programming is weaving patterns with logic. If girls can do calculus, they can write programs. Second, try not to stray from logic. If we make computer science education less dependent on complex software tools, we remove some of the barriers between the student and logic. Third, minimize the use of microcomputers. Microcomputers, for all their cleverness, misrepresent computer science, the study of algorithms, as hardware tinkering. Fourth, ask students new to computer science to write many small functions, just as students of mathematics work countless short problems. Since there is something about the precision of mathematics that young women seem to like, let us try to make computing more precise. Later, as their confidence grows, they can take on larger projects. Fifth, regard programming languages as notation. It could well be that for complex systems, modern languages will produce a better product in a shorter time. But students do not produce complex systems. They produce relatively simple systems with extraordinarily complex tools. Choose a notation appropriate to the problem and do not introduce another until students become skilled programmers. Taken together, these suggestions outline a program to test the hypothesis.

Suppose we test the hypothesis and it turns out to have been correct. Suppose that, as a result, we give computing a makeover, and it comes out as clearly defined and as appropriate to the job as mathematics. Now imagine that able young women flock to the field. How might this change computing? To begin, students will no longer confuse half-formed ideas about proprietary products with computer science. Nor will they confuse the ability to plug in Ethernet cards with system design. It might mean that with a critical mass of women holding undergraduate degrees in computing, systems will be designed, not by tinkerers, but by women (and men) for whom the needs of computer users are front and center. Since stories of systems that failed through an over fondness for complexity are legion (De Palma, 2005), the makeover might even reduce the number of jerry-rigged systems. Thus, does social justice converge with the market place—a very happy outcome, indeed.

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KEY TERMS

Computer Science: An academic discipline that studies the design and implementation of algorithms. Algorithms are step-by-step procedures for solving well-defined problems. A precise description of a technique for putting words in alphabetical order is an algorithm.

Ethernet Card: Hardware that allows a computer to be attached to a network of computers.

Memory Chip: An informal term for RAM (random access memory) or just plain memory. It is internal to a computer and loses its contents when the power is shut off. Programs must be loaded into RAM to execute.

Microcomputer: Also called a personal computer. The machine on your desk is a microcomputer.

Operating System: The collection of programs that controls all of the computer's hardware and software. Important operating systems are Windows XP and Unix.

Program: A sequence of instructions that tells a computer how to accomplish a well-defined task.

Programming Language: The notational system that a programmer uses to construct a program. This program is transformed by another program, known as a compiler, into the instructions that a computer can execute. Important languages are Java and C++.

ENDNOTE

1 This article grew out of a shorter opinion piece in the "Viewpoint" column of *Communications of the ACM* (De Palma, 2001).

Women's Role in the Development of the Internet

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INTRODUCTION

The majority of the literature written about the history of the Internet has focused on chronicling only the technical milestones that led to its development. In doing so, most have overlooked a significant period in the Internet's history, the period bounded by the retirement of the United States Department of Defense Advanced Research Projects Agency's network (ARPANET) in the late 1980s and by the commercialization of the network and the excitement over the World Wide Web browser in the mid-1990s. The historical accounts, as a result, include little more than a passing mention of the National Science Foundation Network backbone project (NSFNet) and Merit Network, Inc., which conducted the transfer of this technology to society at large from 1985 to 1995.

Additionally, the literature holds little evidence of women as a force in the Internet's early development. For example, in *Inventing the Internet*, the most thorough book published to date on the history of the Internet, Abbate (2000) mentions more than 60 different men who were involved in the Internet's development but does not recognize a single woman other than to show a female model advertising a computer. The contribution women made to developing the Internet is similarly neglected in Kristula's *The History of the Internet* (2001), Griffiths' *From ARPANET to World Wide Web* (2002), and Castells' *The Internet Galaxy* (2001).

Overall, readers of the Internet's history are left with the impression the Internet was developed solely by men. This impression is incorrect, as is the impression that the Internet's success is solely the result of a series of technical achievements.

This article presents evidence that many women were employed in the Internet industry prior to the mid 1990s, filling in gaps in the literature on this point. In addition, it suggests that, collectively, women may have held a key role in the extraordinarily successful transfer of the internet technology from a small circle of academics and governmental researchers to society at large. The findings presented here are part of a larger body of work examining the role women held in the Internet's development, carried out at Eastern Michigan University for the completion of a master's thesis in interdisciplinary technology (Repucci, 2004).

BACKGROUND

Data for this study came from interviews conducted with eight of the early participants in the NSFNet project,[1] original source documents, and my own observations and knowledge acquired while employed on the NSFNet project. The individuals interviewed for this research were all employed on the NSFNet project, either by Merit Network, Inc. or by the National Science Foundation's division of Networking and Communications Research Infrastructure (NCRI). They included:

- Merit staff
  - Eric Aupperle, President
  - Elise Gerich, Associate Director of National Networking
  - Susan Hares, Internet Engineer, National Networking division
  - Ellen Hoffman, Manager of Network Information Services
  - Jo Ann Ward, User Services Specialist, Network Information Services division
  - Jessica Yu, Internet Engineer, National Networking division
- National Science Foundation (NSF) staff
  - Stephen Wolff, Division Chief NCRI
  - Jane Caviness, Deputy Division Director NCRI

Table 1. Merit's NSFNet Staff, May 1992

Division	Females	Males	Total	Study Participants
Internet Engineering	4	8	12	Gerich, Hares, Repucci,[2] Yu
User Services	6	3	9	Hoffman, Ward
Network Operations	8	10	18	none interviewed

Note: The data are from Merit's 1992 Organizational Chart (Merit, 1992, May 1)

Employee statistics, presented in Table 1, of the Merit staff who were assigned to the NSFNet effort came from Merit's organizational chart dated May 1992, the last such chart found before the transition of the backbone to a commercial provider. Its purpose is simply to show the gender makeup of the staff during this project, and thus the timeframe of this study. These numbers should be viewed in light of the following historical perspective: "Before NSFNet came along and Merit started to grow, Merit only had one female ... outside of the secretarial staff" (E. Hoffman, interview, February 23, 2003).

Note that while the engineering staff had half the number of women as men in 1992, the User Services staff had the opposite proportions: twice as many women as men. While the published history of the Internet to date has focused on the efforts of the engineers and computer scientists, this paper suggests that the contributions of those involved in the user services campaign were equally important to the success of the Internet's early development.

While this research focuses primarily on the gender makeup at Merit, Merit was only one of the many organizations involved with the NSFNet project where high profile women in the field were employed. A sampling of women from other organizations mentioned in the interviews include: Allison Brown at Cornell University, Deborah Estrin at the University of Southern California, Darleen Fisher at the National Science Foundation, Priscilla Jane Houston at Rice University and the National Science Foundation, Radia Perlman at Digital Equipment Corporation, and Lixia Zhang at Xerox Palo Alto Research Center. Clearly, women were involved in the development of the Internet, and the interview data shows that many were considered key contributors as seen from the interview data.

The concept of inclusion served as a central theme in the examination of gender roles within the project. To this end, the study focused on the formal and informal strategies used to make the Internet more socially inclusive. For the purposes of this work, inclusion was defined as satisfying the following three conditions. First, there must be a clearly stated intent to broaden the user base of the technology. Second, a proactive effort to broaden the user base must accompany the stated intent to do so and the techniques to carry this out must include persuasion as well as educational efforts. Finally, there must be evidence that the user base was, in fact, broadened.

MAIN THRUST OF THE CHAPTER

Originally, this work was undertaken to document the participation of individual women in the Internet's early history. However, in examining the role these women played during this period of history, evidence began to emerge that, while they held a variety of positions and titles that in themselves were impressive—management, engineer, and so on—they also collectively played a key role in the transfer of internet technology to society at large. Specifically, this research suggests that the collective action of the women who were involved in the NSFNet project energized the Internet to be more socially inclusive.

Evidence of women's involvement in the Internet's early history was found in both the interview data and in original source materials. A sampling of the evidence suggesting that women were indeed actively engaged in creating an inclusive user community for the emerging Internet is provided below, presented by the qualifying factors of inclusion, as previously defined.

Evidence of a Clearly Stated Intent to Broaden the Community of Users

This factor deals with the origins of the inclusion goals of the Internet, moving the community of users from a small, fairly homogenous, circle of academics, and governmental researchers to a network representing a wide range of society, including business people, K-12 students, and families. Evidence of intent to expand inclusion beyond the boundary of the NSFNet grant was heard in six of the eight interviews. Broken down by gender, this represents five of the six women and one of the two men. It should be noted that the male participant who commented on this topic had a great deal of influence in defining the original NSFNet project and in its ongoing management. His interview made it clear he had actively sought out and hired staff with strong personal values for inclusion. He commented:

I had a personal goal of the Internet [as] a sort of worldwide, in every home, kind of communications system. I'd had that for a long time. I had had a colleague at Aberdeen ... in probably 1980 ... [He] infected me with the notion of the Internet as sort of a universal communication ... [scheme] for every man and I did believe in that. (S. Wolff, interview, October 26, 2003)

Comments on this topic from one of the women included the following:

I was strongly committed to this network being made available to, for instance, all colleges and universities, including not just the major research universities ... And I think that ... commitment to fairness and a commitment to broadening the educational part of it, as well as the research part, were important things to me. (J. Caviness, interview, May 1, 2003)

The research provides significant evidence that women valued and pushed forward the concept of broad social inclusion in the use of this technology. However, there was little in the research findings to suggest that women had a role in setting the initial agenda for inclusion on the NSFNet project. Both Wolff (2003) and Caviness (2003) suggest in their interviews that the agenda of inclusion may have been established in the initial planning stage of the NSFNet project. This planning stage occurred outside of the time frame examined for this research.

Evidence of a Proactive Effort to Broaden the Community of Users

The effort to broaden the community of Internet users was carried out primarily by Merit's User Services group, which, through its contract for the NSFNet project, was specifically tasked with providing information services to the networking community as well as serving in a public relations capacity to aid in the transfer of the technology to the public sector. Women made up the majority of the User Services staff, as seen in Table 1.

Overall, evidence of having an active role in expanding the bounds of the NSFNet project toward more inclusion was heard in five of the eight interviews. By gender, this represents four of the six women and one of the two men.

Persuasion

Merit's technology transfer effort utilized two primary messages in its persuasion campaign. One was directed at society as a whole. The other was directed to colleagues and other potential organizations in an attempt to swell the membership of the Internet community.

The persuasion effort was carried out primarily by Merit's User Services group, again the majority of which were women. The message directed to society was often couched in terms of the excitement of being able to communicate with everyone in the world, any time of day or night. An example of this type of message emanating from Merit can be found in a 1992 article by L. Kelleher of Merit, "The Internet is a vast ocean of data and resources." It is immeasurably large and no one owns it" (1992, p. 460).

The persuasive messages directed to colleagues tended to promote the Internet as a means of increasing productivity. Examples of this type of persuasion can be found in the 1989 issue of Unix World (Fisher, 1989, p. 43) and in the 1990 issue of Supercomputing Review (Turner, 1990, p. 45).

Evidence of a proactive effort to broaden the community of users by employing persuasion was also seen in the interview data from within the User Services group:

A lot of my responsibilities involved helping people who were not even aware of what a network was, understand why they might ever want to use one, and so we did newsletters, trying to persuade universities why this was important, we did seminars for people from universities to K-12 schools, and even from businesses at a point when nobody knew what the Internet was. (E. Hoffman, interview, February 23, 2003)

Educational Efforts

There is strong evidence in the interview data that the NSFNet project focused significant resources on outreach efforts to organizational members of the project, making the user community aware of the availability of this technology. Examples include:

Ultimately we developed a program of NSFNet seminars ... that were held really across the country ... And creating a collaboratory where the topics of discussion would really evolve from the actual development of the technology to how it could be applied. (J. Ward, interview, February 7, 2003)

When I was at Merit I had an award from NASA in the early 90s ... They sent a contingent of about five of us to Kenya for a week and a half in order to help define the requirements for this interconnection, as well as to understand their requirements. (E. Gerich, interview, October 17, 2003)

Original source data was also found, substantiating the educational theme heard in the interviews. Examples of this can be found in the publication of *Zen and the Art of the Internet* (Kehoe, 1992), *The Internet Companion* (LaQuey & Ryer, 1992), and the *Cruise of the Internet* (Kelleher, 1992), a computer disk-based guide to using the Internet which was widely distributed to librarians across the nation.

Evidence of Success in Broadening the Community of Users

In addition, there is evidence that the members of the NSFNet project successfully expanded the community served by the Internet, beyond its initial focus on the research and higher education community in the United States. Two such examples:

Well, I think that NSF became the organization that brought the work that had been done by ARPA and the development of the ARPANET, that technology ... brought it to a broader community ... Up until then ... ARPANET ... had very limited access, [was] very overloaded and it just was pretty restricted. (J. Caviness, interview, May 1, 2003).

I think it's just absolutely remarkable what developed in the period from the mid-80s until the mid-90s; in a decade's time we went from, essentially ... a pure research environment, the ARPANET format, to a worldwide infrastructure that has continued to grow and blossom. (E. Aupperle, interview, February 21, 2003)

Overall, the research highlighted in this article strongly suggests that women did hold a prominent role in the NSFNet's role of migrating the knowledge of the Internet to the larger society. Additionally, significant evidence was found that the individuals on the NSFNet project, although working in an academic environment, were so group oriented that they did not seek individual recognition and thus did not attempt to publish their experiences. Thus, it is conceivable that at the time of the event the individuals did not see, and thus record to memory, their individual actions as their own. Likewise, it is conceivable that as time has passed they have merged the actions of the group into a more singular memory. Either way, this team-focused mindset may well be masking access to the data on the origins of the social inclusion objective of the project. Additional research may uncover this information if a larger study sample is obtained and/or interview questions are included to assist in breaking down the team focus, thus helping to determine if the data is hidden or simply not there.

FUTURE TRENDS

There is some evidence that more interest in the Internet's early history is emerging, as Web sites depicting this history are numerous compared to the number found when the author began research on this topic in early 2003. Additionally, many university courses can now be found that include portions of this history in their Web posted syllabus.

Few sources, however, have yet been found in the academic literature that specifically explore women's role in the historic development of this technology. It is hoped that the work documented in this article will spark an interest not only in documenting women's participation in the Internet's early development but also in the role women held in the social progression of this technology.

CONCLUSION

The broader purpose of this research was to bring to light historical and social factors regarding the Internet's early development and thus to fill an omission in the historical literature regarding women in the development of this technology. As this article documents, women clearly took part in the Internet's development, as managers, engineers, and technology advocates. This work presents a first look at the social factors involved in the Internet's successful transition to the larger society and the role women held in that transition, dispelling the impression that the Internet's success was based exclusively on a series of technical milestones and that it was developed solely by men. Finally, this work has served to both raise the question of how societal factors influenced the transfer of the internet technology and to assert that women were active participants even though the literature fails to note this.

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KEY TERMS

Inclusion: Defined as satisfying the following three conditions. There must be a clearly stated intent to broaden the user community, a proactive effort to accomplish this, including both persuasion and educational efforts, and there must be evidence that the community of users was broadened.

internet: Used as a common noun denoting any collection of computer networks that are linked together to form a single, larger, network. Each computer network links to the larger network by both a physical link and a common set of network protocols, or language, through which network communications can occur. An internet may, or may not, be connected to the general purpose Internet.

Internet: Used as a proper noun denoting a collection of wide area computer networks, worldwide, that specifically runs the TCP/IP network protocol suite and is dedicated to general purpose access.

Merit, Merit Network, Inc.: A nonprofit consortium consisting of the four-year public universities within the State of Michigan, established in 1966 to provide wide area networking services to the State's educational institutions.

NSFNet Project: Operating from 1985 to 1995 and funded by the National Science Foundation the project was focused on expanding wide area computer networking technology to a broader segment of the university and research community. The project included both the creation of a physical network infrastructure and an organizational infrastructure to promote and manage the physical infrastructure.

NSFNet Collective: The NSFNet collective was formed by the early researchers in the field of computer networking for the purposes of conceiving of and creating the NSFNet project. The majority of the organizations in this collective were high level research universities or facilities in the United States.

Technology Transfer: The process of migrating a newly developed or under utilized technology to a target population.

ENDNOTES

[1] All research participants cited in this article have consented to being identified in publications resulting from this research.

[2] Repucci is included as a participant but due to her role in conducting the study, she was not directly interviewed.

Women's Access to ICT in an Urban Area of Nigeria

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INTRODUCTION

Despite the rapid and revolutionized development of communication and media around the world in the last few decades, which culminated in the term information communication technology (ICT), most of the developing countries are yet to clearly understand its significance or maximize the use of various forms of ICTs, because of other pressing issues such as access roads, potable drinking water supply, electricity and health facilities. This has greatly caused a wide gap between and within countries in the areas of social, economic, political, health and educational developments.

ICTs encompass all the technologies that facilitate the processing, transfer and exchange of information and communication services. Various forms of ICTs exist, such as radio, television, newspaper, telephone, magazine, billboard, Internet, electronic and print media, and so forth.

In the past few decades, there has been a significant increase in knowledge of the importance and developmental trends of ICTs worldwide. ICTs are very important in analyzing one's existing/potential audience using the most cost-effective way to communicate; evaluating the quality of messages; and making provision for information feedback. ICTs bring about various opportunities, ranging from employment and education to economic, health, social and environmental development.

As a result of the digital divide between and within countries, there are uneven disparities between the economic, social, educational and political status of the international community. This brings about classification of countries into "developed and developing" or "haves and have nots."

Gender disparity has served as a strong barrier to women's use of ICTs, considering the fact that women in most developing countries are still considered unequal in status with their male counterparts. This has, thus, reduced enrollment in sciences and technological fields of study. This also is probably as a result of the limited awareness of the full range of opportunities in ICTs other than access to information.

To achieve the goal of universal access to ICTs, there is a need to bridge the gap between men's and women's access to the use of ICTs. This can be accomplished by making technology accessible, relevant and useful to both women and men. State policies could be made holistic by taking into consideration women's needs as well as addressing related issues, such as the urban-rural bias, promoting enrollment of girls in ICTs programs and empowering women to use ICTs for profitable ventures.

BACKGROUND

This survey is being carried out among in-school and out-of-school youths in Benin City, Edo State, Nigeria. Edo State is one of the 36 states that make up the Nigerian federation. It is located in the South-South geopolitical zone, in the Niger-Delta region of Nigeria. The state is administratively divided into three senatorial districts and 18 local government areas. Edo State had an estimated population of 2.86 million people as of 1999. The major ethnic groups in the state are Bini, Ishan, and Afemai, who are collectively referred to as the Edo-speaking people.

Benin City, the capital of Edo State, is one of the ancient cities in West Africa, with more than 1 million inhabitants and a male-to-female ratio of 1:1. It is divided into three local government councils; namely, Egor, Oredo and Ikpoba-Okha. These represent the grass-roots administrative units and make up the major urban areas of the state[3].

Edo State is one of the poorest and least industrialized states in Nigeria, with more than 60% of its population residing in the rural communities. The majority of them are peasant farmers with no feasible means of livelihood.

Despite its poorly industrialized status, Edo State has one of the highest levels of literacy in the country. Nearly 70% of the inhabitants can read and write, which exceeds the national average of 40%. There are currently four universities, two polytechnics, one college of education and several secondary and primary schools in the state.

Statistics reveal that 32.9% of Edo State populations are young adults aged 10-24 years, with about 1:1 male/female ratio (National Population Census, 1991). Data shows that 83% of the adolescents (10-20 years) are in school, while 17% of them are out of school (Okonofua, Kapiga, & Osuji, 2000). School enrollment for girls is significantly less than for boys, and there is a high dropout rate between the ages of 16 and 19 years, mostly among females (Ministry of Education, Edo State).

This survey was conducted to assess women's access to and beneficial usage of ICTs in Benin City, an urban area of Edo State, Nigeria. The specific objectives are:

1. To clearly document the ratio of male-to-female access to ICTs in Benin City.
2. To identify the age and status of female ICT users in Benin City.
3. To identify the purpose of ICT usage among women in the area.
4. To use the data generated to advocate for women's involvement in ICT.

METHODOLOGY

A total of 3,000 in-school and out-of-school female youth aged 15-30 years will be involved in the survey. Information will be obtained using a questionnaire instrument containing open and close-ended questions.

The questionnaire adopted was divided into three sections—namely, A, B and C—comprising demographic status of the interviewees; previous knowledge about ICTs and perceptions of the interviewees on the significance of ICTs to women and actions to be taken in increasing women's access to ICTs, respectively. Also, a table was developed to determine the ratio of male/female access to Internet service in the urban areas of Edo State. The data generated will be analyzed and a detailed report written.

CONCLUSION

We are currently in the process of administering the questionnaires in the three local government areas of the state. By the end of September, the results will be collated, analyzed and processed for a final report.

At the end of the project, the results obtained from the questionnaire should enable us to identify and document the ratio of male/female access to ICTs in the urban area of the state; the age range and status of ICTs users among women; the common types of ICTs, as well as the purpose of ICT usage among women in an urban area of Edo State, Nigeria.

This, we believe, will build our capacity to advocate for women involvement in ICT policy development in the state, as well as to identify active programs or policies in the promotion of ICTs in Edo State.

In addition, we desire scaling up the project by replicating the research study in other parts of the country, particularly each of the six geopolitical zones of Nigeria, because of the significant regional, cultural and religious diversity that exist in the country. This will empower us to have a clear survey of women's access to ICTs in Nigeria.

However, it will further facilitate to develop strategized programs and policies that will increase women's access to ICTs in Nigeria, thereby reducing all forms of gender discriminations in the areas of educational levels, access to good health services, employment opportunities and economic resources in the country.

Conclusively, ICT has been identified as one important tool that has the potential of catalyzing the attainment of the Millennium Development Goals by the year 2015, provided it is well implemented and funded.

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KEY TERMS

Access: Rights or means of approaching or reaching.

Benin City: State capital of Edo State, one of the 36 states that make the nation of Nigeria.

Developing Countries: Poor countries that are building better economic and social conditions.

ICT: Information Communication Technologies.

In-School: Students in secondary or tertiary institutions.

Out-of-School: Students who have completed/dropped out of either secondary or tertiary education.

Urban: Densely populated settlement with large concentrated collection of dwellings.

WSIS Gender and ICT Policy

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INTRODUCTION

The World Summit on the Information Society (WSIS) was organized by the United Nations (UN) and the International Telecommunications Union to address the need for international policy and agreement on ICT governance, rights, and responsibilities. It convened in two phases: Geneva in 2003 and Tunis in 2005. International representatives of governments, businesses, and civil society raised issues, and debated and formed policy recommendations. The WSIS Gender Caucus (2003) and other civil-society participants advocated for gender equality to be included as a fundamental principle for action and decision making. The voting plenary session of delegates produced the *WSIS Declaration of Principles* (UN, 2003a) and *WSIS Plan of Action* (UN, 2003b) in Geneva, with gender included in many of the articles.

Two major issues WSIS addressed in Geneva and Tunis were Internet governance and the Digital Solidarity Fund. UN secretary general Kofi Annan established the Working Group on Internet Governance (WGIG) to define Internet and Internet governance to "navigate the complex terrain" (GKP, 2002, p. 6) and to make recommendations for WSIS in Tunis in 2005. WGIG addressed three Internet-governance functions: technical standardization; resources allocation and assignment, such as domain names; and policy formation and enforcement, and dispute resolution. Relevant issues not initially addressed by WGIG included gender, voice, inclusiveness, and other issues rooted in unequal access to ICT and to the decision-making process including governance, now shaping the information society. On February 23, a joint statement on Internet governance was presented in Geneva at the Tunis Prepcom by the Civil Society Internet Governance Caucus, the Gender Caucus, Human Rights Caucus, Privacy Caucus, and Media Caucus on behalf of the Civil Society Content and Themes Group. The statement asserts, "gender balanced representation in all aspects of Internet Governance is vital for the process and for its outcomes to have legitimacy" (WSIS Gender Caucus, 2005a).

The Digital Solidarity Fund was proposed at WSIS, and the UN Task Force on Financial Mechanisms for ICT for Development was formed. In the 1990s, official development-assistance (ODA) support declined for ICT infrastructure development. In the new millennium, this decline has been offset by funds to integrate ICT programs into development (Hesselbarth & Tambo, 2005). The WSIS Gender Caucus (2003) statement on financing mechanisms affirmed that ICT for development must be framed as a development issue, "encompassing market-led growth but fundamentally a public policy issue." Public finance is central to achieving "equitable and gender just outcomes in ICT for development."

This article examines the WSIS political dynamics over the issue of gender equality as a fundamental principle for action in ICT policy. The WSIS civil-society participants, particularly the Gender Caucus, continued to advocate for gender equality as a fundamental principle for action and decision making within the multiple-stakeholder WSIS process of government delegates and private-sector representatives.

BACKGROUND

The WSIS Gender Caucus was formed at the 2002 WSIS African regional preparatory meeting. The WSIS Gender Caucus presented the following six recommendations for action to the WSIS voting plenary session in the spirit of "creating richness in the information society through inclusion, diversity and gender equality." Gender equality must be a fundamental principle for action. There must be equitable participation in decisions shaping the information society. New and old ICTs must be accessed in a multimodal approach. ICTs must be designed to serve people. ICT empowerment for women and girls is necessary for full participation. Research analysis and evaluation must guide action. These recommendations helped inform the development of the WSIS platform for action.

Many civil-society representatives lobbied the voting delegates for the inclusion of gender equality as a fundamental principle for action in ICT policy. The WSIS Gender Caucus, the NGO Gender Strategies Working Group (NGOGSWG), and other representatives to WSIS advocated for gender equality, basing arguments on the precedent agreements of the *Universal Declaration of Human Rights* (UDHR of 1948), Convention on the Elimination of all Forms of Discrimination against Women (CEDAW; UN Commission on the Status of Women, 1979), the Beijing Platform for Action (BPFA; UN, 1995), and the Millennium Development Goal commitments of 2000.

Global Knowledge Partnership (GKP) helped to structure and coordinate the WSIS civil-society participants at WSIS in the ICT4D civil-society forum. GKP (2002) made recommendations to the digital opportunity task force, an initiative of the G8 nations in 2000, to expand the "digital revolution" to the underserved, particularly women, rural residents, and youth in developing areas. Gender inclusion and mainstreaming were recommended:

GKP experience suggests that gender mainstreaming should be a component of every ICT project to ensure sustainability. A gender perspective must be built into plans, policy and practice, from preliminary project design through implementation and evaluation. The following case studies show that women who are involved in meaningful ICT projects improve their economic and/or social well being in the community. (GKP, 2002, p. 6)

The WSIS Gender Caucus and the NGOGSWG gender advocacy produced results in the documents of the Geneva phase of WSIS. The *WSIS Declaration of Principles* states that the common vision of the information society includes the Millennium Development Goal (MDG) challenges: "promotion of gender equality and empowerment of women; reduction of child mortality; improvement of maternal health" (ITU, 2005, p. 9).

The documents state that gender equality and sustainable social and economic development are crucial for an equitable information society. Civil-society involvement is acknowledged as key to creating broad-based acceptance and therefore sustainable policy and plans for the information society. Civil society has also developed significant content and provision for a critical perspective. The *WSIS Plan of Action* calls for the removal of gender barriers and the development of gender-sensitive capacity building, e-learning and e-health, and early intervention programmes in science and technology that "target young girls to increase the number of women in ICT careers" (ITU, 2005, p. 45).

The WSIS Gender Caucus contributed to the UN Commission on the Status of Women's Beijing +10 review of the platform for action. Section J: Women and Media called for gender equality in media creation and delivery. The caucus reported on how radio, telecenters, and teleconferencing had enabled experts to share knowledge with rural women in agriculture and to respond to information needs. The caucus stressed the value of these ICTs in helping to deliver services to women in health, education, agricultural extension, law, and social justice. Women's participation helps to ensure that women benefit. Woman can demand more accountable governance with transparent information access, and can participate more fully informed in public discourse. ICT can help empower women as development tools for better business, education, and governance participation. All the new ICTs and media provide connection and networking spaces where women can find voice, own and control information and knowledge, and tackle issues of everyday life, sometimes in new and innovative ways (United Nations Research Institute for Social Development [UNRISD], 2005).

Economic disempowerment and illiteracy are major issues of gender inequality that impact ICT in policy and practice. Two thirds of the world's poor and undereducated are women. Even among the 55 countries with the highest United Nations Development Program (UNDP) Human Development Index (HDI), the ratio of estimated female to male earned income ranged between 34:100 and 74:100. Sweden was the lone exception with a ratio of 82:100. The United States ratio was 62:100 (UNDP, 2004). The income disparities exist despite the fact that gross tertiary enrollment is higher for females than males in all but six of these countries. The equalized education and training of women where it occurs has not yet equalized the ICT-sensitive process of input to the world's knowledge resources. Political representation by women has grown since 1990, but for the 55 top HDI countries, the percentage of positions in government held by women still ranges between 0 and 38%. Sweden again was the exception with 45% women in parliament (UNDP, 2004).

Most development research and policy recommends reduced birthrates, found to promote infant and maternal health. Smaller families and improved health allow women more time for education and employment. Gender-equality advocates lobby for ICT skills training for jobs that offer women opportunities for growth from unskilled labor to small-business entrepreneurial efforts, such as the agriculture and cottage industry.

Gender-equality issues in ICT received mention in the WSIS documents, but only nominal attention in the ongoing WSIS process of policy development for Internet governance and financing mechanisms, key issues of the WSIS Tunis phase. UNIFEM continues to fund the WSIS Gender Caucus and efforts to bring greater gender equality to the information society through research, education, and policy decision making.

The WSIS Gender Caucus identified six policy issues during WSIS Geneva, and some were incorporated in the two WSIS documents. By 2005, WGIG had virtually sidelined the gender-equality issue as a fundamental principle for action without mention in the draft report to the UN secretary general. The caucus issued a statement for the June 2005 WGIG open consultation on Internet governance and the report draft:

We believe that the published WGIG outcome criteria lack the basic and fundamental criterion of gender balance and awareness and suggest that these criteria be amended to become

- *equitable distribution of resources,*
- *access for all,*
- *stable and secure functioning of the Internet,*
- *multilingualism and*
- *gender balance and equity*

…We further request that the WGIG consider gender balance as a fundamental issue in its ongoing assessment of Internet Governance mechanisms (current and future), with the aim of equal representation of women and men at all levels in any and all governance mechanisms proposed by the WGIG. (WSIS Gender Caucus, 2005a)

Sabanes Plou (2003) identified patriarchal structures that perpetuate gender-unequal power relations in the media, in ICT research and development, and in ICT labor and policy. Plou examined gender issues of ICT access, participation, and decision making in the information society. Media are the "vehicle for transmission of ideas, images and information," and new media need "new patterns with a gender perspective" to challenge old patterns of control and decision making on access and content (p. 16).

Though ICT labor has been a source of economic growth for some, overall, women work in less skilled, lower paid, and non-decision-making positions in ICT (UNRISD, 2005). ICT access and participation depend on policy and action to address the primary gendered obstacles. Poverty requires affordable ICT. Illiteracy requires education and capability building, and a gendered approach to ICT integration into human communication systems. Patriarchal institutional structures of political, social, and economic power and relationships will continue in ICT without policy and action initiatives for change toward gender equality at all institutional levels.

FUTURE TRENDS

UNIFEM affirmed and supported the WSIS Gender Caucus' continued efforts to provide policy input for the development of Internet governance and the Digital Solidarity Fund financial mechanism for WSIS Tunis. UNIFEM also supported the WSIS Gender Caucus' cooperative work on ICT gender advocacy with the WSIS NGOGSWG, the Association for Progressive Communications (APC), the World Association of Community Radio Broadcasters (AMARC), the WIN network, which coordinated the WSIS media pool, and the Global Knowledge Partnership, which coordinated civil-society WSIS participation in major WSIS process meetings.

WSIS Gender Caucus achievements during the Geneva phase of WSIS were summarized at the closing plenary session (Marcelle, 2003). The caucus advanced some important research trends including support for gender and ICT research, encouraging increased gender-disaggregated-data collection and analysis. Critical gender analysis of the ICT policies of institutions was also encouraged as another important research area. The idea of developing an archive of gender and ICT research was advanced. The caucus organized events and activities in Geneva "enabling decision makers to interact with gender advocates and scholars on alternative visions of the information society" (Marcelle). Current research and expert perspectives were shared throughout WSIS with plans for a post-WSIS "global platform for reporting back to the development community and women's organizations" (Marcelle) in order for governments to be held accountable for the commitments made during WSIS.

Case studies of ICT for development projects that contribute to poverty elimination for women, men, and children are also part of the ongoing research catalyzed by gender advocacy at WSIS. These include projects on "women's applications of ICTs for mobilization, peace and conflict resolution, enterprise creation, trade, education, and health" (Marcelle, 2003).

During WSIS, UNIFEM announced the Digital Diaspora Initiative set up with an E-Quality Fund for African Women and Innovation to provide flexible funding for African women to have opportunities for capacity development and economic security in the information society.

Beyond the concrete WSIS direct outcomes, civil-society participants developed strong networks for information sharing and knowledge building through face-to- face and ICT communication forums. The WSIS Gender Caucus developed its portal (http://www.genderwsis.org) containing useful resources on gender-equality research and advocacy in ICT, and expanded its communications and outreach network.

The WSIS Gender Caucus, a committed group of gender advocates, continued to work with all stakeholder partners, including "governments, international agencies, the private sector and civil society ... to build an Information Society that benefits all of humanity" (Marcelle, 2003). WSIS Gender Caucus efforts support ongoing policy and action committed to gender equality and ICT applications that further the BPFA and MDGs.

The UN ICT Task Force has been "a global forum for placing ICT at the service of development" (Gilhooly, 2005) since 2001. Its mission and action plan were built on the guidance of the Millennium Declaration. It helped advance the multistakeholder discussion on Internet governance. The ICT Task Force helped to create an enabling environment toward the MDGs and to advance the practice of measuring, monitoring, and analyzing ICT impact on the MDGs. It developed an ICT strategy for knowledge creation and promoted cross-sectoral and cross-regional dialogues and partnerships. This included strengthening relationships with the research scholarship organizations International Communications Association (ICA) and International Association of Media and Communications Researchers (IAMCR). The ICT Task Force mandate was extended to 2005 to facilitate the WSIS process.

The ITU Task Force on Gender Issues (ITU-TFGI) has advanced the issues of gender mainstreaming and gender-disaggregated ICT data collection. ITU-TFGI also developed gender-aware guidelines for policy-making and regulatory agencies. The guidelines promote the establishment of gender units in regulatory bodies, gender-sensitive policy analysis, and gender-disaggregated data collection (Jorge, 2001). Research identified that women are "conspicuously absent from decision making structure in information technology in developed and developing countries" (Hafkin, 2003, p. 4), and recommended action to address the inequity.

The many cooperative gender-equality advocacy efforts have contributed to the WSIS decision making and created a policy for change. The future will unfold how these policy agreements will interact with patriarchal institutions over time to bring about real change in practice and real access to ICT with gender equality.

CONCLUSION

WSIS affirmed the MDGs to end poverty and illiteracy, two main obstacles to ICT access for women. International case studies affirm in practice how ICT applications have improved resource and service distribution for health care, education, economic empowerment, conflict resolution, and political, social, and cultural participation.

Gender equality in ICT access, power sharing, and decision making at all levels will continue as issues for dialogue, debate, and research. Active, perseverant voices for change call for humanizing the technology beyond market-economy indicators and creating an environment of cooperation and sharing rather than competition and commodification.

The argument for gender rights and equality in decision making for the information society continues to be advanced through many advocates and venues beyond WSIS. The importance of decision making was articulated well by Nobel Peace Prize winner and world leader Nelson Mandela (2004):

Our freedom and our rights will only have their full meaning as we succeed together in overcoming our divisions and inequalities of our past and in improving the lives of all, especially the poor. Today we are starting to reap some of the harvest we sowed at the end of a South African famine. Many…have spoken of a miracle. Yet those who have been most closely involved in the transition know it has been the product of human decision.

WSIS, gender, and ICT policy are integrally connected within the process of human decision making, capable of creating a world of gender justice, equality, and peace.

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KEY TERMS

Beijing Platform for Action (BPFA): Action program produced during the 1995 Beijing Fourth World Conference on Women. The BPFA defined strategic objectives for action in 12 areas identified as essential to developing gender equality and compliance with the 1979 Convention on the Elimination of all Forms of Discrimination against Women. Global progress on the BPFA was reported at the 2000 Beijing +5 United Nations General Assembly Special Session (UNGASS) and the 2005 Beijing +10.

G8: Group of eight nations with the strongest economies, including, Canada, France, Germany, Italy, Japan, Russia, the United Kingdom, and the United States.

Human Development Index (HDI): An index used by the United Nations Development Program to measure development. HDI is composed of health indicators, infant and maternal mortality and life expectancies, education indicators of literacy, and economic indicators of gross domestic product (GDP).

NGO Gender Strategies Working Group: Formed at the first WSIS Prepcom Meeting in

Geneva in July 2002 as one of the subcommittees of the Civil Society Coordinating Group (CSCG). The groups currently involved in this effort are the African Women's Development and Communications Network (FEMNET), Agencia Latino Americana de Informacion, Association for Progressive Communication-Women's Networking Support Programme (APC-WNSP), International Women's Tribune Centre (IWTC), and Isis International-Manila. The working group is open to all NGOs and individuals interested in gender issues and the information society (http://www.wougnet.org/WSIS/wsisgc.html).

WSIS: The World Summit on the Information Society is a two-phase international summit from 2003 to 2005 organized by the United Nations and the International Telecommunications Union to address the need for international policy and agreement on ICT governance, rights, and responsibilities.

WSIS Declaration of Principles: It affirms gender equality and other MDGs:

Our challenge is to harness the potential of information and communication technology to promote the development goals of the Millennium Declaration, namely the eradication of extreme poverty and hunger; achievement of universal primary education; promotion of gender equality and empowerment of women; reduction of child mortality; improvement of maternal health; to combat HIV/AIDS, malaria and other diseases; ensuring environmental sustainability; and development of global partnerships for development for the attainment of a more peaceful, just and prosperous world. (ITU, 2005, p. 9)

WSIS Gender Caucus: Formed during the WSIS African Prepcom in Bamako in 2002 when representatives of organizations responded to an invitation by UNIFEM to contribute to ensuring that gender dimensions are included in the process of defining and creating a global information society that contributes to sustainable development and human security; they issued the WSIS Gender Caucus Bamako Statement (http://www.genderwsis.org).

Young Women and Persistence in Information Technology

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INTRODUCTION

The underrepresentation of women in science, technology, and engineering careers is of growing national concern (Vesgo, 2005; National Academy of Engineering, 2002; National Science Foundation, 2004; National Research Council, 2001). While the information technology (IT) workforce appears to be becoming more diverse in terms of race and country of birth, it is becoming less diverse in terms of gender (AAUW, 2000; Malcom, Babco, Teich, Jesse, Campbell, & Bell, 2005; NSF, 2004; Vesgo, 2005). This trend is of particular concern, since women may face unequal access to rewarding IT careers, while society and the IT workforce suffer without the valuable contributions that women might make through the creation of new information technologies (Cohoon, 2005; Freeman & Cuny, 2005).

Past studies have highlighted a tendency of talented young girls to enroll in less rigorous mathematics courses beginning in the middle grades (e.g., Kerr, 1997) and have hypothesized that this lack of preparation creates a barrier to science, technology, and engineering disciplines. In response to the increased under-representation of women in IT, Girls on Track (Got), a year round enrichment program and summer camp, was created in 1998 to encourage talented middle school girls to persist in taking college-bound courses in math, science, and computer science through high school. It was our conjecture that some of these well-prepared girls would later become creative future IT workers.

We have undertaken a longitudinal study of approximately 200 girls who were enrolled in the NSF funded 1999-2001 Girls on Track program, with the goal of creating a model of persistence of these young women into IT careers. This study is now in its seventh year. In this article, we present our somewhat surprising findings. It would appear that talented young women, though prepared and able, are not choosing to pursue IT careers. We suggest some ways the thinking about IT may need to change to encourage broader career-level participation.

BACKGROUND

The demand for information technology workers is projected to surpass demand for all other occupations through 2012 (Sargent, 2004), yet overall enrollments in IT-related fields continue to decline (Zweben, 2005). The percentage of women in IT has also continued to decline (Malcom et al., 2005; Vesgo, 2005). The reasons for this are not well understood, although the "dot-com bubble" deflation in the 2000 may play a part (Malcom et al., 2005). In recent years, the achievement gap in mathematics and science has been closing as more women select advanced courses in high school science and mathematics (National Science Board, 2000). However, enrollments of young women in computer science courses and advanced placement (AP) exams in high school continue to remain low (AAUW, 2000; CCAWM, 2000; Freeman & Cuny, 2005).

Some researchers examine girls' experiences from the middle grades to high school for the root causes of women's underrepresentation in IT. For example, Freeman and Aspray (1999) note that girls have less experience with computers and perceive IT-related work to be solitary and competitive, requiring long hours and unsafe working environments. During this age range, many girls become more involved in extra-curricular activities and take less rigorous courses (Kerr, 1997). At the same time, girls lower their career aspirations between the middle grades and high school (Kerr, 1997), through choosing less competitive careers and post-secondary institutions. Since the rigorous preparatory courses for prestigious fields, including courses in advanced math, science, and technology, are often filters for technical fields, these factors may have a strong influence on women's participation in IT. Our previous findings indicate that parental influence may also be a strong factor in girls' choices (Howe, Berenson, & Vouk, 2005).

Several studies that explore recruiting and retention of women in undergraduate IT curricula have reported factors that positively influence the enrollment and persistence of women in IT-related fields. Margolis and Fisher found that prior class experiences, as well as interest in computers and the promise of the field, were primary motivators for majoring in computer science (2001). In the first national study exploring gendered outcomes in undergraduate computer science programs, Cohoon found that faculty attitudes and behaviors could have a powerful influence on gendered attrition. Factors significantly correlated with higher retention rates for women include: having sufficient faculty, responsiveness to the job market, and faculty who mentored for the purpose of retaining underrepresented minorities (Cohoon, 2005). The availability of same-sex peer support and professional experiences are also important factors in women's retention in computer science programs (Blum & Frieze, 2005; Cohoon, 2005).

Recent results from efforts to gender-balance the undergraduate program at Carnegie Mellon indicate that fundamental misconceptions about computer science, as opposed to gender differences, may be the root cause of the under-representation of women in IT, as well as the declining interest in computer science overall (Blum & Frieze, 2005; Vesgo, 2005; Zweben, 2005). Computer science, Blum and Frieze (2005) argue, is not equal to programming, although the advanced placement exam in computer science reinforces this unfortunate misconception.

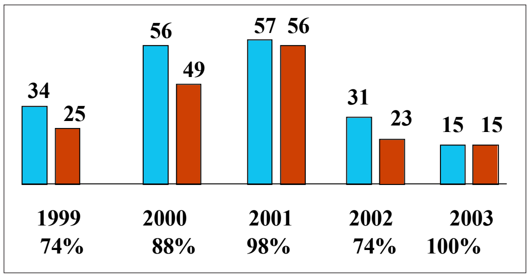
In January 2005, Freeman and Cuny identified several areas where efforts could make a difference in broadening participation in computing, including defining computer science to override popular misconceptions, training faculty in cross-cultural mentoring, providing research experiences for undergraduates, and working with K-12 teachers to define computer science curricula.

A recent study sponsored by the American Association for the Advancement of Science and the Commission on Professionals in Science and Technology includes an insightful discussion of the complexities of the IT educational and employment markets, and recommends policies to support the increased diversity of the IT workforce (Malcom et. al, 2005). These recommended policies include a change in admissions criteria—by shifting the emphasis from programming experience to problem solving skills that are relevant to IT/CS. Four year institutions should offer more career guidance and workplace experiences, as well as opportunities for nontraditional students to take courses online or while working full-time. These recommendations align with findings at Carnegie Mellon, where these types of changes have been effective in increasing the participation of women to about a third (Blum & Frieze, 2005), while national averages of participation for women are less than 20% (Vesgo, 2005).

GIRLS ON TRACK: INSIGHTS

Girls on Track, a program funded by the National Science Foundation (NSF #9813902) from 1999-2001, was created in response to the need to increase women's representation in IT-related careers. The Girls on Track program provided1 year-round enrichment for mathematically high achieving girls in grades 7 and 8. We define high achieving girls as those selected to take Algebra I on the "fast track," thus enabling them to take Advanced Placement Calculus in high school, a necessary preparation for college courses in mathematics, sciences, engineering, or computer science. The age range was 11-13, with about 60% Caucasian, about 30% African American, and about 10% Asian.

Figure 1. GoT participants still "on the fast math track" in 2004



Girls selected for Girls on Track participated in a two-week summer learning experience that included group projects using math and information technologies to address community problems, increasing girls' awareness of gender issues and career planning, along with time for active math-related games. A mentoring program provided continuing support and enrichment activities throughout the school year. Girls on Track also incorporated a professional development component for middle school math teachers, pre-service teachers, and guidance counselors.

In the creation of Girls on Track, we assumed that high achieving young women would be excellent candidates for future IT careers. However, as we have followed these participants through our NSF funded *Women in Technology* (NSF #0204222) longitudinal study, we have discovered that few of these same young women are taking computer science courses in high school, and although one girl has shown interest, so far none of the initial program cohort (1999) have elected IT programs in college. A parallel study at North Carolina State University, *Pair Programming and Agile Software Development*, revealed a theme of the perceptions of the time needed for IT careers, which we found echoed in our interviews of Girls on Track participants.

There are certainly social, personal, and school components that enter into the decisions of the girls to stay involved with IT. In our studies, we are tracking 207 girls using a number of indicators such as proportional reasoning test scores, annual math achievement scores, math attitude (eight factors), courses taken in math, science, and computer science, and PSAT and SAT scores. We have found that a surprisingly large number stayed "on the fast math track" as we have defined it. Approximately 90% of the girls in this study remain on the fast math track until their junior year. At this time, some girls are advised to take a third year of algebra, while others are tracked into advanced mathematics, leaving about 75% of the GoT girls on the fast track. Figure 1 illustrates these percentages for each year of the program; the first bar for each year indicates the total number of students we have been able to follow over time while the second bar shows the number who are taking advanced math courses.

Phone interviews of 39 girls from the first and second cohorts found only one who expressed an interest in an IT career in high school, and only 6 who have elected computer science courses in high school. Five of these six girls noted the low numbers of girls in the courses, and expressed their dissatisfaction with the course content. Only one reported that she liked her CS class and enjoyed solving problems. Only one student took four CS classes in high school, reporting that she enjoyed her CS classes but she is not considering a career in IT.

Reasons a sample of interviewed girls gave for this low CS enrollment in high school include: (a) a lack of interest in computer science, (b) computer science was not an advanced or advanced placement (AP) class (and therefore also provided no extra GPA points), (c) students had no room in their schedules of other advanced classes, (d) computer science is not a college entrance requirement, and (e) some students preferred other electives, such as music or medical academy. These successful young women are willing to work hard but do not wish to be bored by the work, and as these reasons for avoiding CS classes show, they wish to enroll in courses which show clear evidence of advancing them toward college entrance requirements.

These results show both positive and negative aspects. High achieving girls continue to enroll in advanced math courses and are motivated to learn and to find a career that will be both interesting and beneficial to society. They receive strong support from their families and teachers. However, most of these girls do not elect CS courses in high school, do not enjoy CS courses when they do, and few express interest in IT careers, even though 35 to 40% of Girls on Track participants were interested while in middle school.

Although firm data are not available on the effects of the low involvement of girls in high school

CS courses on collegiate IT enrollments, evidence seems to indicate that the limited computer and programming experiences of talented girls can affect admissions into IT/CS departments (e.g., Blum & Frieze, 2005). How to influence the choices of these girls, however, remains an open issue.

In-depth interviews with 30 high school girls revealed that more than half have no image or have incorrect images about "computer science" careers. Some perceive "computer science" as the use of tools such as spreadsheets and databases rather than the design and development (creation) of tools, and the repairing of hardware rather than the engineering of hardware. The creative and inventive benefits of IT careers were hidden from these girls.

Parents are a powerful influence in these girls' lives: two thirds of the young women we interviewed attribute their academic success to their parents. Many of the young women have parents working in the IT industry yet had little to no idea what their parents' work really involved. For those who were more informed about IT careers, more than 20% commented that work with computers required too much time while nearly the same number stated that they did not want to work in a cubicle environment.

One young woman who planned to pursue an IT career spoke positively of her father's IT career in a large company acknowledged for its campus-like, worker-centered environment. This lead us to conjecture that parents' workplace experiences and attitudes may be an important factor in high achieving girls' decisions (not) to pursue IT careers. One possible way to counter these effects would be to provide computer science and engineering experiences that engage girls in inventing, rather than simply using the technology.

The girls in our Girls on Track program exhibited an enthusiastic view towards information technologies while in middle school. However, in our follow-up *Women and Information Technology* study we found few of these same young women interested in high school computer science courses 2-4 years later. None of these high achieving young women have yet elected IT concentrations in college. Yet 75% of the young women in these longitudinal studies take calculus before high school graduation. On the other hand, the study is not over yet. We do not know whether, once they finish the college, these girls who are certainly capable of succeeding in IT careers, may still choose to re-enter IT career paths laterally.

A parallel study at North Carolina State University, *Pair Programming and Agile Software Development*, is a pedagogical intervention to increase face-to-face collaboration in an upper level software engineering course. Interviews with young college women taking this course revealed that the instructional interventions of pair programming and agile development methods saved time, an important value for them (Berenson, Slaten, Williams, & Ho, 2004). Examining the transcripts of the high school girls' interviews for evidence of the "time" theme, we found that some believed that computer science careers demanded too much time, based on their observations of their parents' career experiences in IT and their observations of high school computer "boy geeks."

Having "enough time" for other activities was not an issue for these same girls while in middle school. This difference implies that young women place more value on time and on having freedom to engage in several activities as they mature. This suggests that long hours of university study combined with the long working hours necessary to advance in IT careers may not be attractive to many young women. Margolis and Fisher (2001) speak of the discouragement college women feel when comparing their values with the intensity and focus found in the computer geek culture. To attract women into IT careers, the existing cultures of IT in the university and in the workplace may require a change.

FUTURE TRENDS

A balanced inclusion of women and men into IT should introduce new innovations and improved working conditions for all IT workers (CCAWM, 2000). This balance should also provide the peer support that is particularly needed in recruiting and retaining women in IT (Cohoon, 2005), and should lead to increased opportunities for leadership and full participation (Blum & Frieze, 2005).

However, to achieve this balance, substantial changes may need to be made in the culture and perceptions of IT from within, such as those changes made at Carnegie Mellon University in recent years (Blum & Frieze, 2005). University admissions criteria and advanced placement courses should emphasize the creative and problem-solving aspects of IT, and shift away from a focus on programming (Malcom et. al, 2005). In addition, introductory IT/CS courses should de-emphasize programming and provide a broader view of IT/CS. In order to achieve this goal, it may be necessary to foster IT/CS education programs to prepare teachers and students for new ways of teaching and learning IT/CS concepts and skills, including pair programming and agile software development practices (Berenson, Williams, Michael, & Vouk, 2005). Professional experiences, including mentoring and opportunities for early exposure to real IT applications and careers, should be made available to all students.

CONCLUSION

Providing all U.S. citizens with the "opportunity to gain the skills and knowledge to compete" in the IT workforce will enable the U.S. to remain competitive on a global scale (Malcom et. al, 2005, p. 20). Creativity and innovation, which require a much higher level of preparation, are key in our nation's ability to compete. The participation of women and under-represented minorities will ensure a diversity of perspective that can enrich the quality of innovation in IT.

Findings from our Girls on Track and Women in Technology studies indicate that, although girls are participating to a greater degree in advanced mathematics preparation, high achieving girls are not enrolling in IT/CS courses or choosing IT careers. To recruit these talented girls, we believe it will be necessary to make substantial changes in the culture of IT, including both perceptions and education. Respecting the values of young women and other nontraditional populations, including the need for time for life outside of work, while also maintaining high standards and emphasizing the problem-solving and creative aspects of the field, can make broad improvements in working conditions, diverse participation, and innovation in IT.

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KEY TERMS

Agile Software Development: A philosophy of software development that values people, collaboration, response to change, and working software More information is available at. http://agilemanifesto.org

Girls on Track: An intervention program designed to keep talented middle school girls on the "fast math track." More information is available at http://ontrack.ncsu.edu.

IT Career: A career requiring an electrical engineering, computer science, or computer engineering degree. Emphasis is placed on technical and creative roles rather than support roles.

IT Education: A proposed new field to prepare teachers to introduce students to IT in more effective ways.

Nontraditional Student: Women and underrepresented minorities often enter the IT workforce through nontraditional pathways, including part-time education, through for-profit trade schools, or by starting a baccalaureate degree after the age of 21.

Pair Programming: An agile software development process wherein two programmers work side-by-side at one computer, collaborating to write software.

Women in Technology (WIT): A longitudinal study of Girls on Track program designed to model the educational persistence of young women in IT-related fields. More information is available at http://wit.ncsu.edu.

ENDNOTE

[1] The program is still successful and continues annually under various sponsorships.

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