Reconfiguring the Firewall

Recruiting Women to Information Technology across Cultures and Continents

edited by

Carol J. Burger
Elizabeth G. Creamer
Peggy S. Meszaros

Reconfiguring the Firewall

Reconfiguring the Firewall

Recruiting Women to Information Technology
across Cultures and Continents

edited by
Carol J. Burger, Elizabeth G. Creamer, and Peggy S. Meszaros

Contents

Acknowledgments

This volume reflects the equal and interdisciplinary collaboration among the three editors. From the nascent idea for an investigation about how girls make career decisions that can lead to jobs in computer-based fields, to seeing the need for an international gathering about the topic, and finally, to the development and production of this book, we have worked together in a way that has made the outcome greater than the sum of its parts.

The Women and Information Technology team at Virginia Tech has had the good fortune to work with two able and conscientious doctoral students, Anne Laughlin and Soyoung Lee. They have helped us in innumerable ways over the five years since the inception of this project, through the planning and organization of the conference, to the project completion as presented in this volume. In addition to her role as coauthor of one of the chapters, Anne Laughlin played a particularly influential part in preparing the final manuscript for publication. Anne reviewed all of the chapters and edited them to eliminate duplication while linking their key findings to the thread that flows through the volume. She made substantive contributions to the concluding chapter and developed the index. We are grateful for her timely and insightful contributions.

We thank the conference participants who helped frame the research and action items we have included and those who completed manuscripts for

this book. We especially acknowledge the help of Bill Aspray, Jane Butler Kahle, and Lesley Parker, who reviewed abstracts, acted as discussion leaders at the conference, reviewed and commented upon chapter submissions, and coauthored the introductions to the parts of the book.

Carol J. Burger, Elizabeth G. Creamer, and Peggy S. Meszaros

Part I

Introduction

Sizing up the Information Technology Firewall

Carol J. Burger, Elizabeth G. Creamer, and Peggy S. Meszaros

Carla, a sophomore in high school, can't remember when she first used a computer; there was always one at home and at school to use. She enjoys using the computer to communicate with her friends, find information for schoolwork, and play games. She doesn't think computers are just for boys and doesn't think of herself as a "nerd." Her mom says that Carla is the member of the family they call on to "fix the computer" when something goes wrong. Carla's mom thinks it's important for Carla to have a good career. When asked about career plans, both Carla and her mom think she should go into the same business as her father and brother—they are bill collectors.

Why would a young woman who has the interest and ability to use computers not think about pursuing a computer-based career, such as one in information technology (IT)? What was missing from the advice she was getting that resulted in her not seeking out more information about IT careers? When we began contemplating these questions, we wondered if girls who consider careers that are not traditional for women face different developmental demands as they process conflicting information, wrestle with stereotypes, and, at times, encounter negative feedback. We further wondered how girls' interests vary across cultures and regions. As we rethink these questions in light of new scholarship that specifically targets the career decision-making processes, areas of future research are uncovered and practical implications appear.

In the process of uncovering research about the factors that influence and support IT career choices for women, we found some interesting cultural differences in girls' perceptions of career paths open to them. We found evidence that the "women in IT" question has received worldwide attention through a number of international conferences. The GASAT (Gender and Science and Technology Association) conference encourages the presentation of research about all aspects of gender differentiation in science and technology education and employment, while the European Gender and ICT Symposium has merged with the Christina Conference on Women's Studies and now has a broader cultural focus. There are also regional and local conferences that feature research about women and information technology, such as AusWIT,

the Australian Women in IT Conference, and the WINIT International and Interdisciplinary Conference on Gender, Technology, and the ICT Workplace at the Information Systems Institute at the University of Salford, UK.

The three coeditors of this volume first began talking about an international conference in 2002. We envisioned a relatively small conference structured for the maximum amount of interaction between and among participants and presenters, and where the travel expenses of some of the presenters would be supported in order to ensure that participants could come from around the world. With support from the National Science Foundation (NSF), Microsoft, Texas Instruments, and Cisco, we developed and produced a conference in Oxford in the United Kingdom in July 2005. We invited three well-known discussants for the three sections of the conference. Drs. Jane Butler Kahle, Miami University; Lesley Parker, Curtin University, Perth, Australia; and William Aspray, Indiana University, are scholars who are well known and respected for their research about women and STEM (science, technology, engineering, and mathematics) careers.

The conference attracted 50 participants from all over the world. Participants at the conference included researchers who had been funded by Ruta Sevo in the Program for Gender Equity, and Caroline Wardle of what was then called the IT Workforce Grants at NSF. They came from Australia, Africa, Asia, North America, and Europe. The international group of scholars who gathered in Oxford discussed a wide range of issues that reflect the rapid transitions that are occurring within IT. Friendly differences quickly became apparent as conference participants raised questions about a number of assumptions that have framed research about women and IT. Participants raised such provocative questions as:

- Does the academic convention of emphasizing gender differences and downplaying areas where there are no significant gender differences in research papers unintentionally serve to perpetuate gender stereotypes about the place for women in the IT world?
- Is the pipeline metaphor still useful given that women enter computing jobs in numerous ways?
- Does the assumption that there are no longer significant gender differences in access to computers minimize pressing issues of access that continue in non-Western countries, particularly Africa?

Goals and Audience for this Book

The primary goals of this book are to synthesize key research findings and conference discussions that cross the secondary, post-secondary, and professional settings in different countries; disseminate results of global

research conducted about women's participation in information technology and education; and establish an agenda of critical areas for future research about women and IT. The chapters in this book also touch on retention issues at all levels.

The audiences for this work include K–12 educators, college faculty and advisors who implement activities and programs designed to increase interest in IT, those who fund these programs, academic researchers, and IT industry professionals committed to a diverse workforce. These practitioners and scholars will find the studies in this volume illuminating and prescriptive as they design new, more effective intervention programs and plan future research.

What Is IT?

Information and communication technology is a field where change is so rapid that it is difficult for practitioners, researchers, funding agencies, and policymakers to promote agendas that keep pace with it. Nowhere is this more evident than in the disagreement among researchers and practitioners about the utility of the term "information technology" to embrace fields of study as diverse as computer engineering, information systems, network engineering, and computer science. The term information technology (IT) or, as it is known outside of the US, information and communications technology (ICT), embraces both computer and communications hardware and the software used to automate and augment clerical, administrative, and management tasks in organizations. It is a term that includes all forms of technology used to create, store, exchange, and utilize information in its various forms including business data, conversations, still images, motion pictures, and multimedia presentations. The interweaving of IT, telecommunications, and data networking gave rise to ICT; Western Europeans favor the term ICT, in part, because it may be more attractive to women who favor career options in a field that is more "people oriented" than hardware oriented. Our use of IT is explicit because we are concentrating on the study of computer-related fields rather than on the adoption or use of technological inventions and products.

At the beginning of the IT revolution, most of the innovation was produced by computer scientists and computer engineers. In the mid-1980s when US women's graduation rates from computer science (CS) departments rose to 37 %, there was great hope that the burgeoning IT field would be a place where women could participate equally with their male peers. However, in the later part of the twentieth century, the rate of women entering CS declined and has remained virtually flat for the past 20 years. For

example, US women received 32.5% of the bachelor's degrees in CS in 1981; 29.6% in 1991; and 27.6% in 2001 (NSF, 1994; NSF, 2004). The percentage decline was not more startling because the number of males who chose CS as a major also declined over this period; this mitigated the percentage decline of females in the major even while the total number of female CS majors was in a steep decline. Meanwhile, the college graduation rates for women in the life sciences and mathematics reached parity with men, but the promise of equity in a physical science, engineering, or technology (SET)[1] field did not materialize. Over time, the participation of women and minorities in the technology explosion has been uneven and limited even as the number of IT job openings increased.

Since 1980, science and engineering jobs have been created four times faster than other US jobs. The Americans who fill them, however, are aging and stagnant in number, leaving others to fill the gap. The National Science Board (2004) predicts that between now and 2012, the US will need to train nearly 2 million more scientists and engineers. While women represent 46.6% of the US workforce, only about 35% of the US IT workforce is female (Information Technology Association of America, 2003). More disturbingly, women hold only 10% of the top US IT positions, and fewer women are rising up the IT leadership ladder than in the past (Gibson, 1997; D'Agostino, 2003). The impact on society of the relative absence of women in IT careers is that women's perspectives and concerns are not reflected in the design, development, implementation, and assessment of emerging technologies. There are also economic implications for women if they are not prepared for a career in one of the fastest growing and financially rewarding career opportunities. To fill the gap in IT workers, women must consider IT as a viable career path. What is required to recruit women into IT careers in any significant numbers? Our purpose is to uncover the factors that influence females' interest and choice of IT as a career field, and how this varies across race and culture; this purpose is at the heart of the previous question and forms the basis for this volume.

Access to technology is still the number one issue for people in developing countries. Sophia Huyer (2003) of the Institute for Women's Studies and Gender Studies at the University of Toronto, Canada, reported on the relative numbers of women with access to IT education and training in light of the gendered roles and sociocultural customs these women face. Huyer, Hafkin, Ertl, and Dryburgh (2005) analyzed the worldwide gender digital divide, focusing on developing regions of Africa, Latin America, and Asia. Information from the 33 countries they examined showed that, even when controlling for infiltration of technology (computers and Internet access as well as cell phones and fax machines) into a particular society, women

were still less likely to have access to IT than their male counterparts. The gender gap among IT workers is radically altered when governments, such as those in India, Singapore, and some parts of Africa, promote IT jobs as a key element of economic development.

The disparity in numbers of women studying and working in scientific and technical fields has been discussed and studied from the perspective of two frameworks: as a result of individual barriers, such as innate gender differences in ability or socialization factors, or as a result of institutional barriers, such as the scientific culture and male-oriented pedagogy and curricula. Most researchers now reject the idea that there is a genetic difference in mathematical or scientific ability between males and females, but they continue to seek to determine the interplay among individual differences, cultural socialization, and institutional policies—both written and unwritten— that lead women to dismiss IT and other SET fields as viable career options. As research about women's interest in SET fields has grown increasingly more sophisticated over the last twenty years, research has moved to the use of comprehensive models that encompass both individual and structural qualities.

Challenges in Recruiting Women to IT

Some researchers have struggled to understand why even proactive efforts to recruit women to degree programs in computer-based fields often are not successful (e.g., Cohoon, Baylor, & Chen, 2003). Even when they have both skills and interest in computers, females of all ages consistently express less confidence in their technological skills (Gurer & Camp, 1998; Lee, 2003; Sax, Lindholm, Astin, Korn, & Mahoney, 2005) and often fail to make a connection between skills, interests, and career choice (O'Brien & Fassinger, 1993). A number of researchers have been baffled by the discovery that, unlike men, women with little access to or knowledge of computer applications are more likely to express interest in the field than those who have had broader exposure. Perhaps because stereotypical views are often explicitly or implicitly reinforced in many interactions about careers, we found in our own study that women's interest in IT diminished over time and as they had more interactions with others about the field (Creamer, Lee, & Meszaros, in this volume). While it is unlikely that unrealistic views about the nature of the field will translate to persistence, it is equally evident that considerably more attention is required to evaluate the types of information and strategies that are effective in recruiting young women to IT.

Increasing the number of women of all races and cultures who are interested in IT requires considerably more ingenuity than simply delivering information in an engaging way. Initiatives, like summer programs, are apt

to be effective when they invite parental involvement and manage to communicate personal concern and interest in young women who are participating in the activity. While emphasizing that the field has the potential for lucrative positions seems to influence men, women are more likely to be interested in activities that portray the creative aspects of the field and its potential to address pressing social problems. Activities that engage students in reflecting about skills, interests, and values and how these match a number of career options are critical to making a well-informed career choice. Recruiting efforts can have a significant impact on the career interests of women when they extend over a long enough period of time so that a sense of community and trust is fostered.

Understanding Factors that Predict Women's Interest in IT

Our interdisciplinary team has used self-authorship theory as a research framework (Baxter Magolda, 1999). At the center of the Information Technology Career Interest and Choice (ITCIC) model we developed is a set of variables related to how students process new information to make career decisions (see Chapter 1 for a full discussion of this model). The ITCIC model indicates that many students lack the skills to evaluate information about unfamiliar careers and to offset negative or stereotypical information they hear about IT and related fields. Understanding this process has particularly strong implications for students from low socioeconomic status (SES) backgrounds, rural settings, and/or where they have no one in their immediate circle of trusted others who works in an IT field. One of the greatest challenges faced by educators in the IT field is to present career information in a way that encourages students to consider career options that are not modeled by people in their immediate environment.

Our model, as well as much additional research, underscores that parents are integral to the career choice process, even through the college years. It is important to provide materials directly targeted at educating parents about career options in IT. Involving parents in pre-college activities designed to expose students to information about a variety of IT careers is likely to have a direct impact on women's interest in IT. Parents, advisors, and parent groups like the PTA (Parent Teacher Association) can go a long way to advancing the consideration of a wide array of career options by helping parents learn how to promote mature decision-making. The ITCIC model demonstrates that secondary and post-secondary school women in our sample who expressed an interest in a career in a computer-related field share five characteristics:

- They are minorities (African Americans, Asian Americans, Hispanic Americans, Native Americans, and multiracial Americans).
- They perceive that their parents support this career choice.
- They use computers frequently and in various ways.
- They have positive views about the qualities of workers in the IT field.
- They have not sought out much career information about the field.

High school and college men in our sample who express an interest in IT share most of these characteristics. They, however, are less directly impacted by their parents' perceptions of appropriate career choices and are even less likely than their female counterparts to seek out teachers, counselors, or others for career advice. When it comes to career choice, neither women nor men appear to engage in a systematic approach to career data collection. This is particularly problematic for new and emerging fields like IT where close acquaintances and the media offer only the most minimal insight.

Organization of the Book

This book is organized in three distinct sections that present research about women's interest and persistence in IT majors in secondary schools, post-secondary schools, and careers in the IT profession. These sections represent multiple layers of the gender equity dilemma we face in IT within the US and internationally. We invited Drs. Jane Butler Kahle, Miami University, Oxford, Ohio; Lesley Parker, Curtin University, Perth, Australia; and William Aspray, Indiana University, Bloomington, all of whom are scholars who have researched and published in the area of women and IT education and careers, to act as advisors and to each partner with one of the editors to produce a section introduction. These introductory, integrative pieces synthesize the section chapters, add a broader, international perspective to the topic area (secondary, post-secondary, or professional), and deepen our understanding of the context and consequences of the findings.

The depth of the work presented in this volume springs from the interdisciplinary teams who formed the research questions and conducted their research using a variety of methods. A team of authors from different disciplines—anthropology, human development, computer science, education, economics, biology, business, physical sciences—lends richness to the work and value to the conclusions. Chapters were reviewed by the editors and advisors and accepted for inclusion in this volume based on their theoretical contributions, the quality of the research, and cultural diversity. The chapters broaden our understanding of the barriers and transition points

women encounter as they move through the educational system and into the working world both in the US and in international settings.

Over the course of the development of this volume, the editors, advisors, and chapter authors reached agreement about a few important points that cross cultures and educational levels. We first agreed that, while there are some similarities, findings about the role of gender in the recruitment and retention of women in other SET fields cannot be generalized to computer-based fields. Second, it is important to conduct research that considers differences among the attitudes and skills of workers in different information technology subfields. Finally, we agreed that the public's perception of the 1990s "dot-com bust" and outsourcing of computing jobs does not match the reality of the job market which will continue to expand in all countries—albeit at different rates and with some variation over time.

The Secondary School Level

The authors of chapters in the secondary school section identify key factors precluding females from choosing a pathway leading to an IT career. The themes of failure to connect to the helping or relational interests of females, perceptions of a hostile "geek" culture and extended time required both in study and work life, curricular accessibility in high school, and the difference in support for information processing and decision-making for males and females from teachers, counselors, and parents form the chapters in this section.

A clear theme emerging from our research and that of authors in this section about female secondary school students and career decisions was the importance of a career that captures "helping." This follows previous work investigating the reasons behind the preponderance of female majors in the social and life sciences. The drawing power of the helping professions was seen early in women's participation in nursing and teaching fields. The life sciences, like biology and environmental science, and the social sciences drew large numbers of undergraduate women because of their apparent and overt connection to the human condition. Secondary school students do not often see IT careers as part of the "helping" professions.

In their discussion about how a change in the culture surrounding computer-supported courses could promote girls' long-term interest in IT, Howe, Vouk, and Berenson reinforce the idea that it is the perception of the IT culture as male, competitive, and having little connection to the practicalities of everyday life that keeps female secondary school students from entering and remaining in computer classes beyond keyboarding and, perhaps, Web design. Other perceptions discouraging their sample of high-achieving females from selecting a career in IT were the failures of secondary school

computer science classes to be perceived as both accessible and necessary as well as the lack of supportive teachers.

Berenson, Williams, Vouk, and Michael examined time as a factor in female career decisions and found that perceptions of extended time among their sample made the choice of an IT career unattractive. The long hours of post-secondary study required, combined with the long working hours necessary to advance in IT careers, discouraged their females from choosing the IT career path. The intensity of the computer "geek" culture did not give them the long-term flexibility they desired.

Meszaros, Lee, and Laughlin reviewed models of both male and female secondary school students' predictions of interest and choice of an IT career and found significant differences in their information processing and decision orientation. This finding suggests that a greater support role from parents, teachers, and counselors is needed for females. Specific suggestions for building trust and communicating support are given.

The Post-Secondary Level

The authors of the chapters in the post-secondary section of this volume engage the reader in reflection about different views on the effectiveness of female-targeted interventions. Both Bair and Marcus and Cohoon and Lord argue, in their respective chapters, that female and male undergraduate and graduate students are attracted to computing fields for the same reasons: that is, enjoyment of the activities that can be accomplished with computers. Cohoon and Lord argue, however, "Being gender blind does not attract women into computing." Their demonstration that recruiting by male faculty members and graduate students has a significant negative effect on the enrollment of women in graduate programs in computer science and computer engineering should lead to more research about more effective recruitment approaches.

Authors of two other chapters in this section take a very different view of the appropriateness of gender-centered activities and programs. Blum et al. maintain that "women do not need handholding or a 'female friendly' curriculum in order for them to enter and be successful in CS or related fields, nor is there need to change the fields to suit women. To the contrary, curricular changes based on presumed gender differences can be misguided, particularly if they do not provide the skills and depth needed to succeed and lead in the field. Such changes will only serve to reinforce, even perpetuate, stereotypes and promote further marginalization." For example, having a special preprogramming course for women may give weight to the stereotype of women as less than capable of programming and in need of remedial help. A better approach, used in the Carnegie Mellon University

model, is to reach out to secondary school CS teachers to increase their awareness of the best practices needed to recruit and retain female students who will then be prepared for post-secondary CS courses.

The chapters by Blum, Frieze, Hazzan, and Dias and by Marsh argue that many outcomes attributed to gender differences are largely the result of cultural and environmental conditions. These chapters remind us that it is more accurate to say that the underrepresentation of women is not a universal problem but one that reflects certain countries and cultures. These are settings where IT is less likely to be characterized as a masculine field and where there is strong governmental support for women's participation in economic development.

Several authors challenge the traditional view that access to and use of computers and access to programming classes are essential to effective recruiting to computing majors. Blum et al. point out that the success of Carnegie Mellon University in recruiting women to computing majors was achieved, in part, by eliminating the admission requirement for prior experience with computer programming, a skill that is much more characteristic of male than female applicants. Similarly, Marsh, from Walter Sisulu University, South Africa, demonstrates how a proactive governmental policy can attract women with little prior access or exposure to computers or IT majors. By attracting more women into undergraduate and graduate IT fields, the government hopes to increase its technology workforce and aid in economic growth.

IT Careers

The long-range goal of all gender equity research in the IT fields is to increase the number of women who enter and succeed in IT careers. These can be academic, teaching at the post-secondary or secondary school level; in industry, as a primary IT worker developing hardware or software; or as a network manager or IT technical resource person in any number of private businesses or government agencies. At all levels and in any IT workplace, male IT workers outnumber females. To get a picture of how women and men enter IT, Leventman introduced the concept of multiple pathways into professional IT positions. The pathways, labeled Traditional, Transitional, and Self-directed, are examined and compared to each other in the areas of job satisfaction, career development, technical and supervisory responsibilities, mentoring, networking, and keeping skills current.

Leventman's findings overlap with those of Kuhn and Rayman, which together bring into question the usefulness of the pipeline metaphor for IT. They report that women in IT jobs often get there through circuitous pathways and opportunities. Kuhn and Rayman delved deeper into the "job

satisfaction" area and found that many women and some men were concerned about their inability to balance work and family responsibilities, with work usually winning. Both research projects report that the workers are very satisfied with their work and feel that they "fit into" the IT culture. All IT workers are inquisitive and like solving the puzzles that their work presents. This "puzzle solving" theme is one heard by many interviewers. Both women and men define success in terms of "income, challenge, and recognition." What is not seen is the reason female students report for their interest in the biological sciences—that of "helping people." While this might be an important recruiting strategy, it does not appear to be in the top reasons women stay in or leave their IT jobs. Having enough time for a personal life seems to be more important to those who have stayed in the pipeline long enough to secure an IT position than helping others through their work. This could be the result of some self-selecting out of the IT pipeline because they don't see IT as a career that welcomes those who do want to help people or provide practical solutions for social problems.

Moving from the northeastern US to the antipodes, Warner and Wooller give us a better understanding about the historical timeline of legislation that resulted in equal opportunity/affirmative action laws and policies being enacted in Australia. The driving force for these changes in Australia and, as they show, in the European Union countries, was the realization that in order to be competitive in IT, countries had to support anyone—including females—who had an interest in IT.

As stated above, the goals of programs that deal with females in the education pipeline with additional projects targeted to inform parents, or those that come from informal sources—museum programs, mentoring or networking programs, or summer computer camps, for example—are usually altruistic. Countries and companies are more interested in the economic benefits and prestige that come from having an IT workforce that is inventive and productive. As we see in all of these chapters, the historically male culture of computer science and engineering sometimes subverts these goals. The satisfaction women feel as IT professionals may not overcome the stress of the workplace environment, the choices they must make about whether or not to have children, or the time they spend on the job or commuting to their jobs.

Some of the insight offered by this volume might be reflected in how Carla's decision-making process matured and her interest in IT grew as a result of actions taken by individuals using a new ecological lens to view the barriers surrounding an IT career. We will visit Carla again in the final chapter to see how research put into practice has helped her achieve success in an IT career.

References

Baxter Magolda, M. B. (1999). *Creating contexts for learning and self-authorship: Constructive developmental pedagogy.* Nashville, TN: Vanderbilt University Press.

Cohoon, J. M., Baylor, K. M., & Chen, L.-Y. (2003). Continuation to graduate school: A look at computing departments. Charlottesville, VA: Curry School of Education, University of Virginia.

D'Agostino, D. (2003. October 1). Where are all the women IT leaders? *Eweek*. Retrieved September 29, 2006, from www.eweek.com/article2/0,1759,1309599,00.asp

Gibson, S. (1997, October 6). The nonissue—gender in the IT field. *PC Week, 14*(42), p. 112.

Gurer, D., & Camp, T. (1998). *Investigating the incredible shrinking pipeline for women computer science.* Retrieved June 9, 2006, from http://women.acm.org/documents/finalreport.pdf

Huyer, S. (2003). *Gender, ICT, and Education*. Unpublished manuscript.

Huyer, S., Hafkin, N., Ertl, H., & Dryburgh, H. (2005). Women in the information society. In G. Sciadis (Ed.), *From the digital divide to digital opportunities: Measuring infostates for development* (pp. 135–196). Montreal: Orbicom.

Information Technology Association of America (2003). *Building the 21st century information technology workforce: Groups underrepresented in the IT workforce* [Task force report]. Retrieved October 10, 2005, from http://www.itaa.org/workforce/studies.recruit.htm

Lee, A. C. K. (2003). Undergraduate students' gender differences in IT skills and attitudes. *Journal of Computer Assisted Learning, 19*(4), 488–500.

National Science Board. (2004). *Science and engineering indicators 2004: Vol. 1* (Publication No. NSB 04-1). Arlington, VA: National Science Foundation

National Science Foundation. (1994). *Women, minorities, and persons with disabilities in science and engineering: 1994* (NSF Publication No. 94-333). Arlington, VA: Author.

National Science Foundation. (2004). *Women, minorities, and persons with disabilities in science and engineering: 2004* (NSF Publication No. 04-317). Arlington, VA: Author.

O'Brien, K. M., & Fassinger, R. E. (1993). A causal model of the career orientation and career choice of adolescent women. *Journal of Counseling Psychology, 40*(4), 456–469.

Sax, L. J., Lindholm, J. A., Astin, A. W., Korn, W. S., & Mahoney, K. M. (2005. May). Paper presented at the annual meeting of the Association for Institutional Research, San Diego, CA.

Notes

1. While mathematics is foundational for all of the science, engineering, and technology fields, women have reached parity in mathematics college degrees. Therefore, we have chosen to concentrate on SET rather than on STEM.

Chapter 1

Predicting Women's Interest in and Choice of a Career in Information Technology

A Statistical Model

Elizabeth G. Creamer, Soyoung Lee, and Peggy S. Meszaros

Abstract

This chapter explains a theoretically driven and empirically supported model that identifies key factors that predict high school and college women's interest in and choice of a career in information technology. At the center of the model is the developmental construct of self-authorship and a set of variables related to the process individuals use to make personal and educational decisions. It is our conclusion that reliance on guidance from a narrow circle of trusted others that includes family members, but rarely teachers and counselors, is one reason that women continue to express an interest in sex-typical careers. Findings have direct implications for recruiting and advising practice.

Introduction

Research since the early 1970s indicates that a different set of variables is required in models that predict women's and men's career interests and choice (O'Brien & Fassinger, 1993). There are, for example, significant gender differences in how men and women become interested in, enter, and remain in the computing field (Almstrum, 2003). A number of factors are associated with women's career interests that are not significant for men, including self-efficacy (Bandura, 1982), consideration of the needs of others (Taylor & Betz, 1983), attachment to parents (Armsden & Greenberg, 1987; O'Brien, Friedman, Tipton, & Linn, 2000; Rainey & Borders, 1997) and the value awarded to marriage and a family (Fassinger, 1990). There is a much weaker connection for women than there is for men between interests, enjoyment, and career choice (O'Brien & Fassinger).

The purpose of this chapter is to explain a theoretically driven statistical model that identifies key factors that predict high school and college women's interest and choice in a career in IT. Chapter 4 in this volume,

by Meszaros, Lee, and Laughlin, examines the impact of most of the same factors for a subset of the population, high school women and men. By IT, we mean a full range of professional careers that are computer driven, including those that involve Web design and development, and hardware and software engineering, but exclude data processing. Although the model has been documented statistically through path analysis of 373 female respondents, we set out to explain it a nontechnical way in order to reach a wide audience. Our target audience includes not only academics engaged in research about gender and IT, but also educators who design and implement programs targeted at recruiting and retaining women in IT majors and careers. To clarify our discussions about female students' characteristics in our model, we also used comparison data from 404 male respondents.

At the center of our theoretical model is the developmental construct of self-authorship (Baxter Magolda, 1992, 1999) and a set of variables related to the process individuals use to make personal and educational decisions. In the model, this process is represented by four variables: decision orientation, receptivity, information sources, and information credibility. These variables relate to the role of information from others in career interests. Analysis of data from 170 interviews with high school, community college, and college women between 2002 and 2005 alerted us to the salience of this set of variables.

Figure 1 depicts the full conceptual model. Key findings from analysis of both our qualitative and quantitative data have led us to conclude that for both male and female high school and college students, the 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 fam-
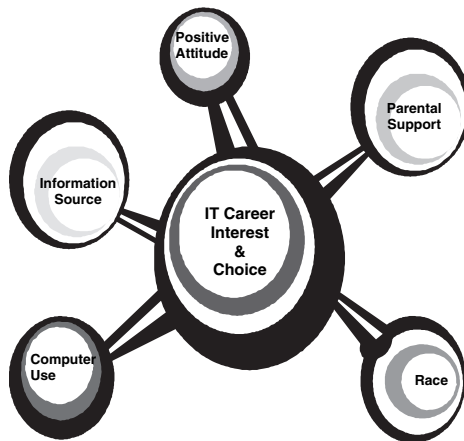
Figure 1. The conceptual model.

ily members. In general, women who expressed an 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. Surprisingly, the fewer contacts our respondents made to talk about career options, the more likely they were to express an interest in an IT career. Because this indicates that individuals are making career choices with little self-reflection and circumscribed information, this finding does not bode well for the likelihood of long-term persistence in the field. Findings support the conclusion that one of the biggest challenges facing educators who want to promote women's interest in SET fields (science, engineering, and technology) is to develop a portfolio of developmentally appropriate strategies that engage young women in thoughtful reflection about career options that are good matches for their values, skills, and interests.

Summary of Key Findings

In addition to the exogenous variables that are controlled for in our model (birth year, educational level, and mother's and father's educational level), there are five key variables that impact women's IT career interest and choice in a direct and indirect way. Variables with a statistically significant direct impact are (a) race, (b) parental support, (c) computer use, (d) positive attitudes about the attributes of IT workers, and (e) information sources. Variables that have an indirect impact on women's interest and choice of a career in IT are (a) parents' education levels, and (b) decision orientation.

In the section below is a description of a fictional character, Kiaya. Kiaya is a composite figure who integrates the central findings from the qualitative and quantitative findings of our long-term research project.

Kiaya: The Next Generation IT Worker

Kiaya is an African American college sophomore who completed high school in a suburb of a large metropolitan city. Kiaya was raised in a two-parent, middle class home. Both of her parents completed a college degree and both are employed full-time in a professional position. Kiaya had access to a home computer from a young age. She uses a computer daily for a variety of purposes.

Kiaya has positive views, rather than stereotypical views, about the attributes of IT workers, thinking that they are smart, creative, and hard working. She is moderately confident she can solve computer problems when she encounters them. She knows people employed in the IT field and who

enjoy working with computers. She is not particularly concerned that IT is a male dominated field.

Kiaya's parents, particularly her mother, are key to understanding the process she uses to make important life decisions, including the choice of a career. They believe that the IT field is an appropriate choice for their daughter and have encouraged her to talk with others who are acquainted with the field. They have promoted Kiaya's confidence in her own judgment by modeling effective decision-making. They have encouraged her to seek input from informed outsiders when making an important life choice, while at the same time repeatedly underscoring the importance of making choices that match her values, interests, and skills. In these ways, Kiaya's parents have promoted her development of self-authorship.

Our fictional composite, Kiaya, presents the key characteristics that we have found through empirical research to be associated with high school and college women's interest in a career in IT.

First, they are more likely to be a minority than Caucasian.

Second, they have parents who support the importance of a career and encourage career exploration. Their mothers have completed a higher level of education than those who express little or no interest in a career in IT. Participants who expressed an interest in IT had parents who felt that IT offers job options that are a suitable match with their daughter's interests and skills.

Third, participants who expressed an interest in a career in IT used computers in their home from an early age. They use computers on a daily basis and for a variety of purposes, including social exchanges through email or instant messaging. They feel reasonably confident that they can solve problems they encounter on the computer. Some have had the opportunity to be employed in a setting where computers are used for problem solving.

Fourth, participants who expressed an interest in a career in IT have positive views about the attributes of workers in computer-related fields, believing that they are smart, hardworking, and creative. They do not endorse stereotypical views that workers in these fields are "geeks," "loners," or "antisocial." The fact that IT is a male-dominated field is not considered a significant deterrent to interest in the field.

Fifth, Kiaya is an ideal character, compared to many of our participants, in that she has had the advantage of parents who have promoted the development of mature decision-making skills and encouraged her to genuinely reflect on the input of informed outsiders without disregarding her own personal values, skills, and interests. Kiaya has played an active role in seeking out career information and has given thought to the input of others both within and outside of her immediate family, including from teachers,

counselors, advisors, and professionals in her fields of interest. Her parents' style of parenting has promoted the confidence Kiaya feels about making decisions. Kiaya is further along in the journey toward the development of self-authorship than most of our participants.

In the remainder of the chapter, we will summarize our theoretical framework and details of our research methods. A list of questionnaire items in each variable, plus statistical information about the reliability of the variables in the model, appears in the appendices. The central portion of the chapter is organized around key variables in the model. In the section about each variable, there is a summary of the relevant literature, a description of key findings from our research, and a brief discussion of the comparison to men in our sample. Each section ends with reflections about the implications for practice. We reacquaint you with Kiaya in each section by repeating the relevant portion of our composite character.

Theoretical Framework

We employ the developmental construct of self-authorship as a theoretical lens to understand the cognitive processes students use to make decisions, including career decisions (Baxter Magolda, 2002). 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 is grounded in the work of Perry (1970) and Kegan (1982). Self-authorship is linked to decision-making because it influences how individuals make meaning of the advice they receive from others and the extent to which the reasoning they employ reflects an internally grounded sense of self (Baxter Magolda, 1998, 1999, 2001).

Individuals at different stages of cognitive development have different ways of approaching decisions. Individuals early in the journey to self-authorship—a stage Baxter Magolda refers to as external formulas—are likely to make decisions that reflect unquestioned faith in the views of trusted others. They trust others to know what career choices best fit them. Those who have advanced to the middle point of the development of self-authorship—what Baxter Magolda calls transitional knowers—have lost the comfort of unquestioned trust in authorities, but have yet to develop other criteria to judge input and make decisions. They are skeptical of authorities, but have no systematic set of criteria to approach decisions or to evaluate knowledge. It is only after achieving a full measure of self-authorship that an individual can be genuinely open to the input of others, without allowing the exchange to erode a sense of self. A self-authored career decision is one that is made with the internal compass of a clear sense of self, an open-

ness to the input of others, and a sense of the match between the demands of a field and personal interests, values, and skills.

Developmental theorists provide a framework that is at odds with the assumption that high school and college students automatically accept the word of learned authorities. They offer developmental reasons for why many college students may not be in a position to genuinely engage diverse viewpoints from unfamiliar others, including from advisors and teachers. First and second year students of a traditional-age are likely to be absolute knowers (Baxter Magolda & King, 2004). They are engaged in dependent relationships where decisions are made to please trusted others, like parents and friends. It is probably difficult for this group to accept advice that conflicts with the guidance provided by trusted others. College juniors and seniors are most likely to be transitional knowers (Baxter Magolda, 1999) but still have no systematic way of approaching personal decisions and few criteria to judge the advice of others. Trust and care for the person offering advice may become the principal criteria for making a life decision (Creamer, Lee, & Laughlin, 2006) because until the later stages of epistemological development individuals have few criteria other than the nature of the relationship to judge advice or the advice giver (Hofer & Pintrich, 1997).

Methods

Research Participants and Data Collection

The overall data collection and analysis procedures consist of three phases: the first survey and interview data collection, the follow-ups and revisions, and the second survey and interview data collection testing our theoretical model and subsequently revised survey questionnaires and interview protocols.

First phase of data collection (2002). For the first-year data collection, letters seeking cooperative agreements to participate in this project were sent to high schools, community colleges, and colleges in Virginia. We received written letters of agreement from ten high schools, two community colleges, and four colleges in rural and urban locations in Virginia and distributed the survey questionnaires about participants' computer-related attitudes, career influencers, and career decisions to these schools during spring 2002. A total of 467 participants returned completed usable questionnaires for a 62% response rate (467 of 750). The first-year survey participants consisted of (a) 346 females (74.1%) and 121 males (25.9%); (b) 177 high school students (37.9%), 118 community college students (25.3%), and 172 college students (36.8%); and (c) 322 whites (69.0%), 139 minorities