Shortchanging the Future of Information Technology: The Untapped Resource

Angela M. Balcita
Dept. of English
Chatham College
Pittsburgh, Pennsylvania 15232 USA
<angela@cs.pitt.edu>

Doris L. Carver
Dept. of Computer Science
Louisiana State University
Baton Rouge, Louisiana 70803 USA
<carver@bit.csc.lsu.edu>

Mary Lou Soffa
Dept. of Computer Science
University of Pittsburgh
Pittsburgh, Pennsylvania 15260 USA
<soffa@cs.pitt.edu>

Abstract

Building on ideas from a virtual workshop and additional input from the scientific community, the CISE Directorate at the National Science Foundation established the Information Technology Workforce Program (ITWF) in March 2000 to support a broad set of scientific research studies focused on the under-representation of women and minorities in the information technology workforce. In this paper, we explore various approaches that the funded researchers are taking to address the problem of women in information technology. We begin with a brief history of the ITWF, and then focus on some of the research projects in terms of their goals, approaches, and expected outcomes.

1. Introduction

The pervasiveness and usefulness of Information Technology (IT) in our society has dramatically changed our everyday lives. While all in our society have benefited from the results of our movement into the information age, not every group has fully participated in the design, development, and implementation of information technology. Women are clearly the forgotten resource in IT. In all levels of educational institutions across the nation, girls and women remain under-represented in computer and information science studies, and subsequently, in the technological workforce.

In 1999, a report from the Presidential Information Technology Advisory Committee (PITAC) confirmed that a diverse IT workforce is critical if the United States is to meet the challenges of the information age [9]. The Directorate for Computer and Information Science and Engineering (CISE) at the National Science Foundation funded a virtual workshop to help identify research issues that educators should consider as a part of a national research agenda regarding the under-representation issue [3]. Building on the issues raised from this virtual workshop, CISE initiated the Information Technology Workforce Program (ITWF) in March 2000. ITWF supports and funds multidisciplinary research teams who explore the reasons why there are such low numbers of women in computing, and the ways in which we can encourage more women to enter the field (see [11] in this special issue). In October of 2001, the awardees of the 2000 and 2001 ITWF grants were invited to participate in an IT Workforce Research Conference in Boulder, Colorado. The meeting not only allowed for an exchange of research practices and initial findings, but the primary investigators were also invited to suggest recommendations and directions for the future. The belief is that by identifying and understanding the barriers and obstacles women face, we can break them down, thereby creating an IT community with full participation of women.

This paper describes some of the approaches that are being explored by researchers funded by ITWF to promote opportunities for women in computing. We describe some of the challenges that women faced in IT, and present some of the approaches the ITWF-supported projects have taken to meet the challenges of improving the representation of women in information technology.

2. Issues and Research in the Under-representation Problem

Although there are theories as to why women are under-represented in IT, there are no definitive answers to the problem. However, researchers speculate that the factors contributing to the low number of women in the field fall into three basic themes: Environment and Culture, the IT Educational Continuum, and the IT Workplace. In this section, we examine each of these themes and look at some of the ways the funded researchers are approaching these issues. While we touch on just a few of these studies, abstracts of all 29 ITWF-funded projects are available at the websites [14] and [15].

2.1 Environment and Culture

The image of IT itself poses a problem. Shaped by forces we perceive through the media, in the community, and even in the home, images of IT are often negative in the way they stereotype IT workers, the work setting and the work involved in the trade. The content of electronic games and toys, for instance, tend to appeal to boys, losing the attention and interest of the young female audience. Playing these games at an early age allows boys to form a comfortable

relationship with technology and computers, while girls miss this early interaction with technology.

Books, magazines, television shows, and movies also lend a hand developing the picture of IT and the IT worker. Shows like "Bill Nye the Science Guy" and "Mr. Wizard" represent the strong male influence in science. While shows like these create role models for young boys interested in science, they lack female role models with whom young girls can identify.

Even factors at home and at school can influence a child's perception of IT. Thinking that girls do not like math and/or science, parents will assume that a home computer would have greater use if they placed it in the son's room rather than the daughter's room. In school, boys are clustered around computer workstations, making girls question whether or not their own interests in computers is acceptable. Such influences are subtle, but can create a difference in how young girls and women see IT, and how they imagine their roles in it.

Research Approaches to Environment and Culture

Considering the power of environmental and cultural factors, one group of researchers is attempting to understand what effect electronic games and toys might have on the image children develop of IT, and the possibilities they might see for themselves in the field [1]. Researchers of this study speculate that the metaphors of IT presented in these games tend to focus on machinery and machine parts as opposed to problem-solving and designing issues, which may reinforce negative perceptions young women have of the IT field. Studying mainly middle and high school students, researchers plan to test this theory by, first, conducting interviews with students to understand their attitudes of IT, and, second, by observing students as they participate in game sessions in order to find the activities that prove successful in developing positive attitudes toward IT. Identifying the conceptions school children have of IT, and understanding the effect electronic games and toys have on these conceptions are the main goals of this project. In identifying these issues, it will be possible to design tools and games that appeal specifically to girls, which may create a positive image of IT, and attract more young women into the field.

Also, within the context of culture, another project looks at the ways in which IT and IT workers are portrayed in magazines, books, and other media [2]. In order to test whether these factors reinforce or hinder negative or positive images of IT during the course of a student's development, researchers will identify books, magazines movies, and television programs that are available to middle schools and libraries and are reportedly popular among young adolescents. After identification, these media forces will be analyzed in terms of how they portray the involvement of women and minorities in the IT field, and how middle school students see gender roles in IT through media images. This study is unique in the method with which researchers are gathering their data. By having the middle school students survey each other about these media issues, the researchers of this project are applying "action research." An advantage to applying this form of study on this subject is, by students and teachers analyzing the content of these forces, it may heighten their awareness for messages they are receiving through the media.

One unique study closely examines the effect of intensive integration in technology in the high school curriculum [7]. Using the foreign language immersion program in education as a model, researchers hypothesize that a similar technology immersion program will make students comfortable with the IT environment, and therefore, more likely to choose the field as a college major or eventually as a career. The project focuses mainly on an all-girls private high school in which students receive a laptop at the beginning of their freshman year. After taking classes on the use of its hardware and software, each student should use her laptop as the primary tool for all her coursework. In this study, researchers will observe, interview, and survey high school students currently enrolled in this IT immersion program. They compare their responses to those from two other groups: older students who attended the same high school and studied under a similar curriculum without technology immersion and female high school students from another local, private, co-ed high school who are offered IT enrichments classes and electives, but whose curriculum is not fully immersed in the technology. This study aims to show how differently general IT access and IT immersion can affect a young woman's attitudes and beliefs toward IT. Hoping hands-on programs like this will break down fears and apprehensions students may have about IT at an early age, researchers are attempting to reshape the IT environment by moving it into the classroom.

2.2 The IT Educational Continuum

Though the K-16 education system should help to guide them towards the IT workforce, women often encounter barriers here that cause them to lose interest in the field. As stated earlier, the interest boys have in technology begins early with the games and toys they play, and continues through their educational development. By the time they reach the undergraduate level, they are comfortable with technology environment, lingo, and culture. Young girls, who have missed the same amount of exposure to the technological environment, feel less confident upon entering computer and programming classes.

Introductory programming classes at the undergraduate level typically assign programming projects that may seem tedious and lack purpose or meaning to female students. These types of projects may also discourage women from continuing with the major. Some observe that boys tend to have an explorer-type mentality, finding interest in just "playing around" with the computer and finding out the capabilities of the machine. As women tend to prefer working towards a goal or end, introductory courses, which encourage learning through repetitive exercise and projects without a direct application might not interest them and drive them out of the major.

A support system of role models and mentors is helpful when pursuing a major in some area of IT. With so few women in the field, the number of same-sex role models for women is scarce. Without female faculty guidance, young women can feel isolated in their department, leaving them vulnerable to the negative pressure from peers and from faculty who may question their skills.

Research Approaches to the IT Continuum

The undergraduate pipeline provides a time for some critical career decision-making on the part of the student. The declining number of women graduating with CS degrees is proof that the IT field has trouble recruiting and retaining women at this pivotal stage. It would be difficult to understand these shrinking numbers without closely examining the computer science environment in the universities. One study looks specifically at the undergraduate departments of computer science and the factors involved in retaining female students [6]. With a major focus on faculty, these researchers place an emphasis on the practices of mentoring, motivation, and support in increasing retention rates. Through interviews and surveys, the research team will also discuss departmental policies, faculty attitudes, teaching, and advising practices with faculty, chairpersons, and students. The responses of these department members are expected to give some insight to the differing attrition rates between men and women in the field, and what factors are involved in creating this disparity.

To better understand how the CS curriculum is managing diversity in the classroom, it is necessary to examine how learning behaviors differ between genders. By studying the learning styles and strategies of "successful" and "unsuccessful" students, researchers of this project are investigating how learning behaviors can influence completion of the CS program [8]. Considering that women begin computer science programs with less experience than males, researchers hypothesize that the learning strategies women have are less effective for skills like programming. Observing undergraduate students as they "think aloud," this study will identify strategies that characterize "successful" CS students. From these observations, researchers will create a program to teach students effective learning strategies. In creating this program, and in studying the effectiveness of good learning strategies on undergraduate CS students, researchers will be able provide a computer science learning model that will fit the needs of women.

In a similar effort, another study tests the effectiveness of pair programming [13]. This technique is a type of collaborative learning in which students work together to complete a programming assignment. As one programmer creates the code and keys in the data, another programmer reviews the input information looking for mistakes and errors. After a period of time, they reverse roles. Pair-programming is not only expected to produce more precise code, but it is also expected to improve women's confidence in related tasks and break down negative images of the IT workload and environment. This approach touches on many issues that women face in the IT field, such as the issues of socialization, images, and confidence.

2.3 The IT Workplace

Job satisfaction in any profession usually depends on factors like environment, work hours, workload flexibility, resources, and interactions within the workplace. We sometimes identify these same factors as the barriers that keep women out of IT. In the male-dominated setting that often describes the average IT office, women meet discrimination problems and performance stereotypes in their own office. Furthermore, as they look for support and mentoring through role models and social networks, they come up empty. Without the encouragement and guidance of individuals from their own gender, women are left searching for support.

As the workload of IT careers can often be demanding, women have trouble balancing professional and familial responsibilities. Long hours and heavy, unbalanced workloads are not ideal conditions for women interested in combining work and family. Issues of flexibility and resources can easily change a women's attitude about job satisfaction.

Research Approaches to the IT Workplace

Careers in IT can offer high incomes and vast opportunities for growth and movement. Although these sound like enticing benefits to working in the field, women still choose alternative career paths. As this ITWF program ultimately aims to create a competent and diverse IT workforce, one research team has made it a goal to identify components of the job and factors in the workplace that influence retention and recruitment in the field [4]. They are looking at factors involving job design, organizational structure, job satisfaction, stress, salary, work atmosphere, and discrimination on retention and turnover in the workplace. Surveying employees from three IT companies, researchers are pinpointing the factors that influence retention decisions, paying particularly close attention to women. Using the gathered information, the researchers are interested in understanding how the IT workplace can help retain its own workers, particularly among women. It is also their goal to construct a set of standards to be used by companies to help them evaluate and strengthen their attempts at retention practices.

One frequently debated theory about women in the workplace suggests that women tend to choose careers that involve positions where they can play out their desire to tend to or care for others. Suggesting also that women will take these jobs despite the fact that they usually pay less than what the actual work demands, this theory is under scrutiny by one NSF-supported research team [12]. Their study will attempt to identify labor market barriers that discourage women from IT careers. Utilizing NSF SESTAT surveys, researchers will be able to distinguish specific factors that influence career paths of those who already have IT college degrees. A second portion of the study addresses the theory about women's attraction to lower paying, helping careers.

Those surveyed will be asked questions on issues such as their willingness to sacrifice time and money to assist others. Surveys of young women will attempt to identify perceptions of IT careers and how they differ from more "helping" careers such as nursing. Not only does this study examine stereotypes of women, but it will also examine stereotypes about IT, uncover labor market issues for women, and propose ways to heighten interest and satisfaction in the field.

Recruitment into the IT workforce through non-traditional pathways is also under examination. Labor Market Intermediaries (LMIs) refer to temporary agencies and training providers that not only educate adults in IT, but also assist their graduates in entering the workforce. One research study compares the success of LMI graduates in finding work in the IT workforce to the success of those who enter the field through different paths like college degree programs, short-term public or private job training programs, graduate degree programs or high school education placement [5]. Through interviews and surveys with both personnel managers, and IT workers, more specifically, women workers in the field, researchers will be able to determine the effect of traditional and non-traditional pathways on job retention and career mobility. Researchers suggest that by building connections with employees, LMIs are assisting their students with job placement more successfully than institutes in traditional pathways. Not only is this beneficial to the graduates of LMIs, but researchers also suggest that by facilitating this career guidance, LMIs are helping to restructure recruitment in the workforce.

3. Conclusions

In this paper, we presented only a few of the research projects that have been funded by the ITWF program. The goal of having women fully participate in Information Technology is a difficult one to achieve as it involves cultural, institutional and personal transitions. Only through thorough exploration of issues and approaches and the appropriate funding for the research can any success be realized. As women remain the minority in the Information Technology workforce, we must continue to consider the consequences to our policies, to our technology and to our culture. We need to continue to explore ways that advance and transform our world to include the participation of women, the untapped resource, in Information Technology.

Acknowledgement

We thank Caroline Wardle for suggesting the topic of this paper to us and for her help on earlier drafts of the paper. We also thank the reviewers for their suggestions.

References

[1] Bennett, Dorothy and Cornelia Brunner. *Designing for Diversity: Investigating Electronic Games as Pathways for Girls Into Information Technology Professions.* NSF IT Workforce Research Conference, Boulder, Colorado, October 14-16, 2001. For more information on this project, see: <http://www.edc.org/CCT>

[2] Bernt, Phyllis, Sandra Turner and Joseph Bernt. *Getting the Media Message: Portrayal of Gender Race, and Information Technology in the Media Environment of Middle School Students.* NSF IT Workforce Research Conference, Boulder, Colorado, October 14-16, 2001. For more information on this project see: <http://www.csm.ohiou.edu/mediamessage>

[3] Carver, Doris. *Research Foundations for Improving the Representation of Women in the IT Workforce*, 1999. See: <http://www.cise.nsf.gov/itwomen.html>

[4] Carayon, Pascale, Marla C. Haims, and Sara Kraemer. *Turnover and Retention of the Information Technology Workforce: The Diversity Issue.* System, Social And Internationalization Design Aspects of Human-Computer Interaction, Lawrence Erlbaum Associates, New Jersey, 2001, 67-70.

[5] Chapple, Karen, and AnnaLee Saxenian. *Mediating Careers: The Role of Labor Market Intermediaries in Facilitating the Entry, Retention, and Advancement of Women and Minorities in the Information Technology Workforce.* NSF IT Workforce Research Conference, Boulder, Colorado, October 14-16, 2001.

[6] Cohoon, Joanne McGrath. *National Study of The Gender Gap in Collegiate Computer Science Attrition.* See: <http://vceps.edschool.virginia.edu/vceps201.pdf>

[7] Houston, Andrea, and Sister Judith Brun. *Attracting Women into the Information Technology Workforce through Technology Immersion.* NSF IT Workforce Research Conference, Boulder, Colorado, October 14-16, 2001.

[8] Katz, Sandra, and Mary Lou Soffa. *Learning Behaviors and Background Characteristics that Promote Retention of Women and Minorities in Undergraduate Computer Science Programs.* NSF IT Workforce Research Conference, Boulder, Colorado, October 14-16, 2001.

[9] Presidential Information Technology Advisory Committee (PITAC), *Information Technology Research: Investing in our Future.* <http://www.hpcc.gov/ac/report/>

[10] Information Technology Workforce (ITWR). Program Announcement, NS01-33. http://www.nsf.gov/pubs/2001/nsf0133/nsf0133.htm

[11] Wardle, Caroline, and Lawrence Burton. Programmatic Efforts Encouraging Women to enter the Information Technology Workforce, *inroads (the SIGCSE Bulletin)*, vol. 34, no. 2, 2002.

[12] Weinberger, Catherine, and Peter Kuhn. *Entry, Earnings, Growth and Retention in IT Careers: An Economic Study.* NSF IT Workforce Research Conference, Boulder, Colorado, October 14-16, 2001. For more information on this project, see: http://econ.ucsb.edu/~weinberg/

[13] Werner, Linda, Charlie Mac Dowell, Heather Bullock, and Julian Fernald. *The Effects o f Pair-Programming on Performance in an Introductory Programming Course.* 33rd SIGCSE Technical Symposium on Computer Science Education Conference, Kentucky, Feb. 27-March 3, 2002.

[14] National Science Foundation: <http://www.cise.nsf.gov/eia/cwardle/itwf01_awds.html>

[15] National Science Foundation: <http://www.cise.nsf.gov/itwawd.html>