

# 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.

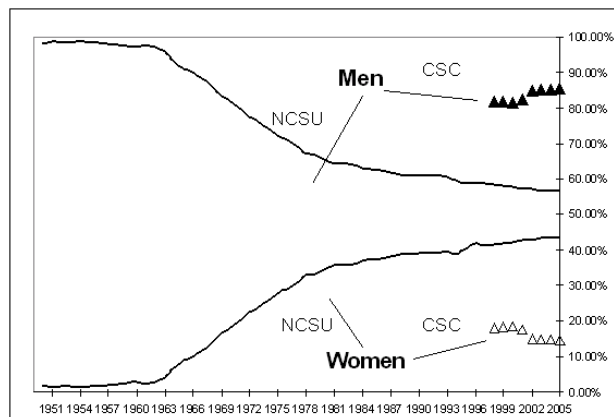
## BACKGROUND

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.

## Participation of Women in Information Technology

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).

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