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
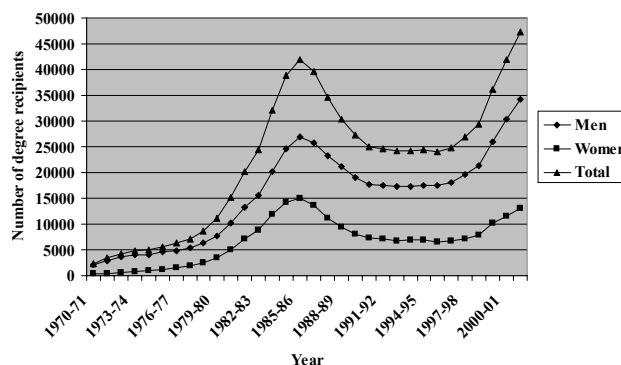
Source: U.S. Dept. of Education, NCES Digest of Education Statistics, 2003

Figure 2. Percent earned degrees in computer and information sciences by gender for selected years, based on data shown in Figure 1
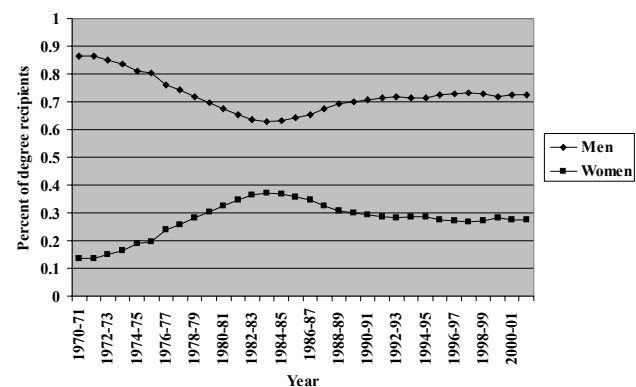

BACKGROUND

Two main forces contribute to the continuous under-representation 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
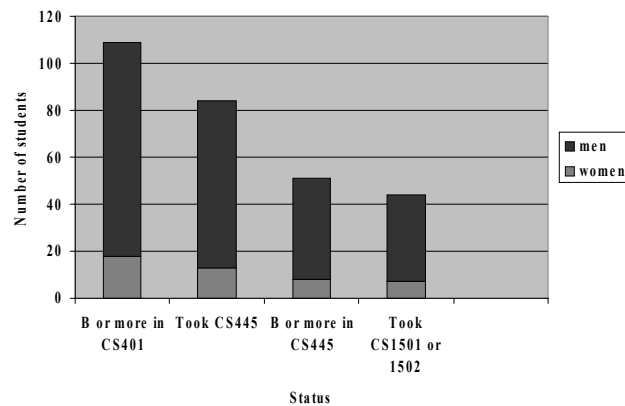
the loss of students who earned a B or above in CS courses at the University of Pittsburgh at two points in the undergraduate CS program, during the period 2000-2004[1]: after taking an introductory course (*Intermediate Programming Using JAVA,* CS401) and after taking *Data Structures* (CS445). Sixty 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, multi-faceted, 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).

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