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IT: THE LAST BOYS' CLUB?

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Abstract

Recent publications have described information technology (IT) as the “career without women.” Unlike some fields that have been traditionally male dominated, the IT field has not increased the representation of women in recent years. The numbers of women in this career is not only small but also shrinking. This paper provides a brief overview of related prior research. Selected prior research is presented in order to explain the choice of hypotheses. The paper describes a variation on Vroom’s expectancy model designed to measure female success in undergraduate information technology (IT) programs. Success will be measured in terms of actual performance in a gateway course, programming principles, as well as satisfaction with the field of study. Interventions to be tested include completion of a freshman experience course, gender of teachers and mentors, and a senior experience course. Results from this study will have implications for designers of IT curricula, as well as employers wishing to attract, retain, and develop a diverse IT workforce.

Theoretical Background

It is generally believed that gender inequity no longer exists in higher education, where women obtained more than half of all undergraduate degrees in 1996 (AAUW 1999). However, women traditionally comprise only a small percentage of students who are enrolled in postsecondary programs in science, technology, engineering, and mathematics (STEM). At the graduate level, the statistics are even more skewed. Women earned the majority of graduate degrees in education and health, while men earned almost 75% of the graduate degrees in computer science and an even greater percentage in engineering (Bae et al. 2000).

Adult learners, who make up almost half of college enrollments overall (AAUW 1999) may be even less likely to choose and complete STEM degrees. In particular, only 1% of women adult learners who returned to college after working out of high school chose engineering degrees, 2% chose technology-related degrees, and none of those surveyed chose mathematics as their major (AAUW 1999). Comparatively, of male adult learners who returned to college after working out of high school, 7% selected engineering majors, 8% chose technology-related degrees, and 3% chose mathematics degrees (AAUW 1999). Further, a smaller percentage of women ultimately receive degrees in STEM.

It is important to note that, while the picture is dismal in most STEM fields, it is particularly grim in the information technology (IT) field. A recent publication describes IT as the “career without women” (Mayfield 2001). Here IT is defined in the broadest sense to include information systems, computer science, management information systems, computer information systems, and related areas. Representation of women in college computer studies has decreased from 37% of undergraduate degrees in computer science in 1984 to 20% in 1999 (Kellogg 2001), with only 15% of the Ph.D. degrees in the computing sciences being awarded to women in 1996 (Carver 1999). At some institutions, the statistics have been even bleaker. For example, at the Massachusetts Institute of Technology, women computer science majors made up the lowest percentage of any undergraduate degree offered (Adams et al. 1995). And even when women do enroll in IT-related fields, they leave the computer science program at twice the rate of their male counterparts (Margolis et al. 2001).

The statistics available clearly illustrate that women do not choose or complete STEM degrees as often as men, particularly IT related degrees. Studies have suggested making the classrooms more gender friendly, including actively encouraging participation from both sexes (Brown University 1996) to attempt to overcome gender-related issues. Further, fostering an environment where professors are more involved with students – both male and female – has been suggested as a means of improving the situation for women, who tend to look favorably upon a nurturing environment (Hewitt and Seymour 1992). Moreover, institutions can

play a role in attracting and retaining women students in IT by allowing substantial transfer credit for older women (AAUW 1999) who may have attended multiple colleges in many locations over the years.

Some claim that students are appropriately discouraged from pursuing IT degrees due to a lack of aptitude. Does this explain the dearth of women in IT? Interestingly, Seymour (1993) found that female students said that one of the primary reasons that they left STEM was that “morale was undermined by a competitive culture.” Again, males appear to be less affected by the competitive culture seen in many science classrooms, where grading on a curve is common. In addition, significantly more women reported that professors did not take an interest in them (Scientific American 1998), and that perceived indifference by the professors influenced their decision on which major to choose. Studies have consistently shown that women receive less support from professors than their male counterparts, particularly in STEM. Mentoring has often been suggested as an option that can positively impact females staying in STEM disciplines (Didion 1996) at the undergraduate as well the graduate level (Holgate 2000). For example, the Carnegie Mellon Big Sister/Little Sister Program, which pairs first and second year computer science majors with upper-level women computer science majors (Blum 2001; Cohoon 2001) has been very positively received.

Recently, women have made many inroads in STEM disciplines. For example, in recent years, women have earned more than half of the mathematics degrees (De Palma 2001). The same holds true for many science fields, including biology and chemistry. Why, then, has female representation in IT actually decreased over the last two decades? Indeed, is information technology the last bastion of the boys’ club? Numerous papers have called for research into why women are underrepresented in the IT field (Foster 2000), how educators can better recruit women into IT fields (Carver 1999), and how to design intervention programs to recruit and retain women in IT fields (Blum 2001; Cohoon 2001). Further, intervention measures at various universities have shown great promise in increasing representation of women majors in computer science. For example, at Carnegie Mellon, 7% of entering freshman computer science majors were women, compared with 40% in the fall of 2000 (Blum 2001), after intervention, recruitment, and retention programs were undertaken. Other universities (e.g., University of Michigan 1996) have also reported similar successes after concerted efforts to engage, mentor, and retain women students were undertaken. This paper identifies intervention measures that may improve retention and success experienced by female students with an initial interest in IT. This research-in-progress paper describes a series of hypotheses based on theoretical underpinnings, along with proposed methodology and outcomes.

Model Development

Expectancy/valence theory provides an appropriate framework for understanding and addressing the variables that influence selection of and success in an IT career by gender (Beise and Myers 2002). Initially proposed by psychologist Vroom (1964), this theory emphasizes the relationship between the individual and the work environment. Vroom includes two important classes of individual perceptions: valence and expectancy. Valence is the individual’s cognition about the value of a particular decision (choosing an IT career). Expectancy is the individual’s expectation of success with that decision, similar to self-efficacy. A test of Vroom’s model involves identifying interventions and determining their effect upon valence and expectancy, which leads to success in the IT field. Independent variables include involvement in mentorship, gender of mentor, gender of teacher, enrollment in the freshman experience and the senior experience classes. Dependent variables include success in programming classes, and intention to pursue graduate work or a career in IT.

Hypotheses

If, as theory suggests, women do not fail to achieve IT degrees due to technical incompetence or lack of desire, how then can we as IT educators increase the success of females in the IT pipeline? The model in Figure 1 outlines our hypotheses, which are further discussed below.

First, research has shown that using mentors may increase the retention and graduation rates of women IT majors.

Research further indicates that students may serve effectively as mentors and role models (Adams et al. 1995; Cuny and Aspray 2001). Moreover, females with mentors provided positive ratings on the mentor interaction and reported greater confidence than females who were not given a mentor (Holgate 2000). Since mentor involvement is often seen as being critical to retaining female students – particularly in the first two years, we propose:

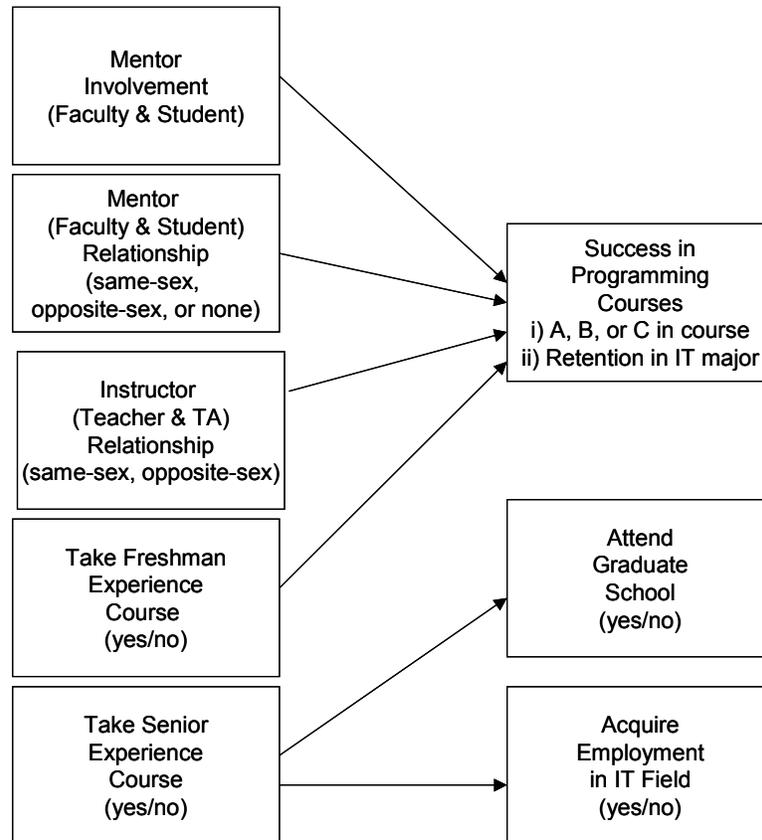


Figure 1. Toward a Model of Success for Female Students in Information Technology

Hypothesis 1: Mentor involvement (faculty and/or student) is positively associated with student success in the programming sequence of courses.

The programming component of an undergraduate IT program usually includes a sequence of programming principles classes. These “gatekeeper” courses often cause significant attrition out of IT-related fields (Myers et al. 2002). We propose that students – particularly women students – will succeed in these “gatekeeper” courses more often when they receive faculty and student mentoring.

For purposes of this study, success is defined along two dimensions. First, success is measured by a passing (A, B, or C) grade. Second, after completing the programming course, if the student’s intention to major in IT has not changed, then we have successfully retained the student in IT. Alternatively, if the student decides not to major in IT after taking the programming course, we have generated a leak in the IT pipeline and have thus been unsuccessful. We plan to record the student’s major both before and after each of the programming courses to secure this information.

Furthermore, since female students often feel more comfortable with female teachers and female teaching assistants, and since same-sex role models provide strong positive effects, we propose:

Hypothesis 2a: Students with same-sex mentors (faculty and/or student) will be more likely to succeed in the programming sequence of courses than students with opposite-sex mentors (faculty and/or student).

However, since students who receive any mentoring appear to do better than students who receive no mentoring, we also propose:

Hypothesis 2b: Students with opposite-sex mentors (faculty and/or student) will be more likely to succeed in the programming sequence of courses than students with no mentors.

Third, and naturally building on the previous hypotheses, female students are more likely to seek assistance from female instructors and are more likely to ask questions of female instructors than male instructors. In fact, women sometimes feel that questions are too “stupid” to ask male professors or male teaching assistants (Blum 2001; Margolis et al. 2001). Further, women tend to be attracted to fields with significant numbers of female teaching assistants and professors (von Hellens and Nielsen 2001). Therefore, we propose:

Hypothesis 3: Students with same-sex instructors (teachers and/or teaching assistants) will be more likely to succeed in the programming sequence of courses than students with opposite-sex instructors.

Fourth, we also propose that taking some sort of freshman preparatory course, often called “The Freshman Experience” or similar titles, should be beneficial to students. Such a course teaches study habits, time management, and the like, and attempts to build a cohort for students to improve retention and graduation rates. Completion of similar preparatory courses has been an indicator of future academic success, as well as a method of improving attitudes and behaviors in general (CUNY 1996). Therefore, we propose:

Hypothesis 4: Students who take the “Freshman Experience” course will be more likely to succeed in the programming sequence of courses than students who do not take such a course.

Beyond success in the programming sequence, students begin to prepare to graduate and to ultimately move on to either the workforce or to graduate school. As a natural bookend to the “Freshman Experience” course, the “Senior Experience” helps students secure a job or get into graduate school. Such a course requires the preparation of a portfolio, provides interview and resume tips, and perhaps financial planning. Therefore, we predict:

Hypothesis 5: Students who take the “Senior Experience” course will be more likely to pursue either graduate school or an IT career than those students who do not take such a course.

Finally, although we will test each of the hypotheses for both male and female students, we predict that females will benefit more than males from this intensive mentoring effort. As previously mentioned, IT is already welcoming to males, and males tend to do well in IT college programs and the IT workforce. Our proposal is an attempt to even the playing field, to assure that women have an equal chance of success. We propose:

Hypothesis 6a: Females will benefit more than males from the intensive mentoring effort that we propose.

Hypothesis 6b: Females will benefit more than males by having same-sex mentors and teachers.

Hypothesis 6c: Females will benefit more than males by participating in the “Freshman Experience” and “Senior Experience” courses.

We will measure the benefit received by analyzing the success of the students – that is, passing grades (A, B, or C) in the programming courses; continued intention to major in IT after completing the programming courses; attending graduate school; and/or securing employment in the IT field. The next section briefly describes our planned methodology and anticipated outcomes.

Methodology and Anticipated Results

To undertake this project, we plan to design and deliver a unique “Freshman Experience” course specifically targeted to STEM female students. However, although this course will focus on gender issues, we will not exclude males from participating in the program. In fact, we will encourage males to participate in the study, to increase gender understanding and to focus on issues of concern for all IT students. We plan to survey the students throughout their tenure to gather information on how to recruit and retain students in STEM. We plan to offer the first targeted “Freshman Experience” course in Spring 2003. Further, we also plan to offer a “Senior Experience” course specifically targeted to STEM female students who are approaching graduation. Again, male students will not be disallowed from participating in the course, and will instead be encouraged to take the course. With the

assistance of the Alumni Department, we plan to survey and monitor these students after graduation to gather feedback on how to make the programs more attractive to female students and how to better prepare female students for the male-dominated IT fields. Throughout the middle years, we plan to offer significant faculty and student mentoring, social gatherings, prominent female IT speakers, and other meaningful networking events, to improve the retention of female students.

We expect that our efforts will lead to an increase in female students choosing and remaining in STEM fields, particularly in IT, where females have not achieved the equitable ratio to males that other STEM fields have seen. Indeed, female representation has declined, and we anticipate that our efforts will alleviate the situation and increase female representation in the last boys' club.

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