INCREASING THE NUMBER OF WOMEN IN THE TECHNOLOGICAL SCIENCES THROUGH ROLE MODEL INTERVENTION

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ABSTRACT

Growth projections by the U.S. Department of Labor Statistics indicate a serious shortage of information technology (IT) workers between 1994 and 2005. In searching for solutions to this problem, focusing on increasing IT awareness among traditionally under-represented groups in American society, presents one possible strategy. Studies generally group the various reasons for the under-representation among American societal groups in IT into four major categories: (1) lack of technology experiences in K-12 education, (2) scarcity of appropriate role models, (3) differences in expectations based on gender, and (4) misconceptions about IT working environments (3). This paper will focus on improving retention among women currently enrolled in CIS by addressing one of the four inhibitor categories.

Keywords: Women in computing, CS retention, Role models in CIS, Internships

PROBLEM RECOGNITION

U.S. industry is experiencing a shortage of information technology (IT) workers. The total number of IT (computer science and related fields) workers in 1988 was 1,259,000 compared to 2,063,000 in 1997 (1). All forecasts indicate the problem will increase more dramatically in the next two decades. A report conducted by the Computing Research Association in May 1999 describes two types of demands, *episodic* and *long-term* (3). The episodic demand was generated by the Y2K problem and will drop off dramatically in the next year. The long-term demand is created by the changes in our society brought about by the integration of technology into mainstream products and will continue to increase. "Technology is rapidly being adopted by every sector of American society and made a fundamental part of organizational operations and personal activity (3)." Technology has also permeated the global economy, thus exacerbating the competition for IT workers worldwide.

Growth projections by the U.S. Department of Labor Statistics indicate a serious shortage of IT workers between 1994 and 2005 in jobs as computer scientists, engineers, systems analysts and computer programmers. The greatest increase in demand in the next decade will be for computer engineers (108%), computer support specialists (102%), systems analysts (94%), database administrators (77%), and desktop publishing specialists (73%) (2).

In searching for solutions to the shortage problem, focusing on increasing IT awareness among traditionally under-represented groups in American society, women, Hispanics, African American and Native Americans presents one possible strategy.

Studies indicate various reasons for the under-representation among American societal groups in IT. These reasons can be generally grouped into four major categories: (1) lack of technology experiences in K-12 education, (2) scarcity of appropriate role models, (3) differences in expectations based on gender, and (4) misconceptions about IT working environments (3). How can the number of people who graduate from information technology disciplines be increased? When the gender demographics of graduates in IT-related fields are examined, it becomes apparent that women are under-represented. Increasing the number of women graduating from IT disciplines will consequently increase the available pool of IT workers. Of concern is the fact that the number of women in computer science has declined, not increased, since 1986. For bachelor's degrees, the number peaked in 1986 when women represented approximately 36% of the total number of graduates in IT. In 1996, approximately 27% of the bachelors and masters degrees were earned by women while only 15% of Ph.D. degrees were earned by women. It is crucial to learn more about why the percentage of women in IT is so low and why the numbers have in fact been declining since 1986 (10).

GOAL STATEMENT

The University of South Alabama's School of Computer and Information Sciences (School of CIS) has approximately the same ratio of men to women in the discipline as the national norm: 24% women; 76% men. The School of CIS offers three specializations: Computer Science, Information Science, and Information Technology.

A 1990 study sponsored by the American Association of University Women suggests that a major problem in attracting and keeping women and minorities in computer science is the lack of role models at all levels … (6). One way to adapt the culture of science to include more women is to "provide role models for girls to emulate and to stimulate their motivations, models of young women scientists who have survived college or are 'living the life of the mind'"(9).

In the study of other once dominated white, male professions, as doctors and lawyers, we find that once "critical mass" was achieved, women were attracted to and remained in these professions proportionally to their male counterparts. The term, critical mass, refers to the minimum number of women in a profession required to demonstrate the profession universally as an achievable one for women.

The solution to the problem of under representation requires strategies in both recruitment to increase the pool of women entering IT programs and retention to increase the ultimate graduation rate, thus leading to the achievement of a critical mass in IT.

Our observations support current studies conducted at other universities that the highest attrition occurs in the freshman programming sequence for both males and females. Will focus on the retention of women in the freshman programming sequence increase the number of women receiving bachelor's degrees in technology, thus increasing the IT workforce? If so, the number

of women available to enter graduate programs would increase, and ultimately contribute to the attainment of the needed critical mass of appropriate role models.

The University's statistics show a disparity in the attrition rate of technical programs versus non-technical programs by gender. 128 of the 280 (46%) first-time traditional freshman females entering our program in Fall 1994 attrited. Of the remaining females who either graduated or are currently still enrolled, 85 changed majors (39% of original group). The University is retaining only 24% of females in the technical majors. The attrition rate for males is about the same, but the men entering the program in 1994 outnumbered the women by over 300%. The raw numbers translate to 67 women completing the program after 5 years versus 251 men.

The School of CIS began to proactively address the problem of under-represented groups among technology majors approximately five years ago by implementing strategies to retain more women in the major. Efforts are focused on increasing the number of appropriate role models for women. Retention rate data on females in CIS from 1997 through academic year 2004 will provide insight to the effectiveness of these strategies. A discussion of these strategies, forming a Women in Computing support group, arranging internships with local industry to tap role model resources, and presenting a preliminary report on data collection are the purposes of this paper.

RESEARCH

A report by the American Association of University Women found "that girls are scarce in computer classes and in high-paying technology jobs and it isn't because machines make girls nervous or because they aren't good at math (7)." The findings of a teacher-student survey, The American Teacher 1997: Examining Gender Issues in Public Schools of 1,306 students and 1,035 teachers in grades 7 through 12 revealed "girls appear to have an advantage over boys in terms of their future plans, teachers' expectations, everyday experiences at school and interactions in the classroom (8)."

A Search Institute survey evaluated the attainment of forty critical development assets of over 99,000 students in grades 6 - 12. These assets, half internal, such as motivation, half external, such as family support, are referred to as "building blocks for healthy development" (8). The survey reported that girls rated higher than boys in thirty-seven of the forty assets. By almost every measure of well-being, girls out-ranked the boys.

The Horatio Alger Association's 1998 survey examined two groups of American students, the "highly successful" and the "disillusioned". The successful students are characterized as hard workers, choose challenging classes, place high priority on school work, earn good grades, participate in extra-curricular activities and feel in control of their surroundings. The disillusioned students are characterized as being demoralized--pessimistic about their future, with low grades and little contact with teachers. Of the successful group, approximately 18% of all students, 63% were female and 37% male. Of the disillusioned group, approximately 15% of all students, 70% were male and 30% female (8).

Studies indicate that girls have the ability and confidence to succeed in science and math based careers, so why don't they?

"In 1971 females made up only 9% of computer systems analysts and other specialists. By 1990, this proportion jumped to 35%. But 1993 noted a decline in representation to only 30% (U.S. Bureau of Statistics). A similar trend was found in the women's share of computer and information science bachelor's degrees (5)."

Educational preparation or lack thereof, is a critical influence on choice of academic major in college. If a student does not identify his career choice as math and science in junior high school, the subsequent inappropriate high-school course selections may make it very difficult, or impossible, to succeed in a technical field in college. A report of the National Science Foundation (NSF96-311) concluded that women take fewer high-level math and science courses in high school (11). Many of the University's students drop out of the freshman programming sequence because they are inadequately prepared. Prolonging the time to complete degree requirements in order to take additional, non-credit, prerequisite courses presents, for most students, insurmountable problems in the areas of finance, ego and family/peer expectations.

Research shows that women earn over $13,000 less per year than their male counterparts. Theories suggest that women do poorly in male-dominated fields because they are few in number, but as the proportion of women in IT increased, the segregation within the occupation declined and the earnings gap narrowed (5). Jacob's "social control" theory suggests that "women receive lifelong social control messages about male-dominated occupations--They do not belong and should not be in them (5)." Likewise, men receive cultural messages that women do not belong and react accordingly toward them in the workplace. Thus cultural influences effect women's decisions to enter male-dominated fields and to stick with them once in a work environment (5). The narrow view of the world of technology as presented to students in middle school is not appealing to the vision most girls have of desirable careers. Surveys indicate that careers in technology are viewed as contradictory to the traditional female roles of wife and mother.

Available resources at the university level require that a professional decision be made to provide support to attract and retain more women into technology related disciplines. Programs designed to attract women into technology at critical, earlier ages are usually beyond the resource constraints of most public universities. Universities can develop strategies to retain the women who present themselves as majors and recruit women from other majors enrolled in technical classes. This paper focuses on the strategy of increasing appropriate role models to increase the retention rate of female technology majors.

"A characteristic of human cognition is that we synthesize our notions of concepts by generalizing based on examples (4)." Women and minorities may mentally, at some subconscious level, associate white males and maleness as possessing the attributes of distinguished scientists; so that when they think of people who have potential to become distinguished scientists, they tend to think of white males.

This tendency to generalize based on examples also plays a role when evaluating one's own potential. When setting our own goals, the tendency is to think about the members of groups we might desire to join. Our similarity or dissimilarity with the group members impacts our assessment of whether we are potential members of the group, as well as our desire to join the group (4).

Additionally, the

> *…lack of appropriate role models inhibits our ability as well as our desire to do anticipatory socialization, which is a process whereby a person who aspires to join a group adopts characteristics of that group.... When women do not perform the anticipatory socialization that implicitly may be expected of aspirants to a position, that failure may be viewed as evidence that they are not qualified or interested* (4*).*

RETENTION STRATEGIES

While attracting females to technology disciplines is critical to satisfying the increasing demands of these professions, at the college level, resources are better focused on retention of females who present themselves in classes. Barriers to female retention include lack of peers in the classroom, lack of representative faculty, laboratory ergonomics, and overall non-existence of support for non-male population. Over the last five years, strategies with the goal to improve the retention of students, especially women, in computer science have been implemented. A "Women in Computing (WITS)" support group was formed in 1996 and evolved into a student chapter of the ACM-W. Lab hours have been extended utilizing more female tutors. Semester "cook-outs" encourage communication among students, and among students and faculty. Scholarships and awards are presented annually. Over 50% of the scholarships and awards have gone to women in the last two years. Our female faculty representation has increased from 2 to 5 of 17, and the School's goal of improved retention of all students, including females and minorities, has reached a heightened awareness level among our faculty and student body. Guest speaker programs featuring women practitioners from industry and supplemental instruction programs have been implemented providing additional academic support and role model exposure.

Significant results from our retention efforts have been slow in coming. The attendance and enthusiasm for the early meetings of the WITS group and guest speaker engagements were, at times, discouraging. In an effort to jump-start the role model pipeline, eligibility requirements for our existing internship program were modified to allow women to enter the program earlier in the academic process. The theory was that if the School of CIS could not currently provide a "critical mass" of internal role models, both in number and appropriateness, then outsourcing was a solution. The plan was to strategically place women in technology related work environments with women co-workers and managers.

The School's internship program is distinguished from traditional co-op and internship programs by the following characteristics:

- Student interns are paid while in the program.
- Student interns receive one semester credit for each semester in the program.
- University receives overhead money for management of the program.
- Faculty member receives release time to manage students in the program.
- Coordinated policies and procedures exist to promote interns to positions of increased responsibility with wage increases.

The five-year-old program has had 151 undergraduate participants, and has grown from one to six industry partners with an additional four new partners pending. The 151 interns consist of 78% males and 22% females. Currently, there are 37 undergraduates in the program, 27%

female, 73% male. Of the 114 former interns, 87% have either graduated or are still attending the University, 18% females and 68% males. Fifteen of the former interns no longer attend the University, two (1 male and 1 female) are known to have transferred to other universities, and the remainder's higher education status is unknown.

In an effort to increase retention of females, the internship program was viewed as a resource to provide additional role model exposure. The prerequisites for the program were restructured to allow female students to enter the program earlier. An alternate minimum ACT score of 23 was accepted in lieu of successful completion of the data structures course (CS 3). This change allowed qualified females to enter the program as freshmen (early entrance interns), thus providing early role model exposure at a critical time in the academic experience.

The change was implemented in spring of 1998. Since that time, 23 females have become interns under the alternate prerequisite structure. Six have graduated, five left the program to accept other positions outside the internship program or to concentrate on studies, two were non-renewed due to poor work performance, two withdrew from school and eight are still in the program.

CURRENT STATUS

The goal of the study is to determine if early placement in a work environment will significantly increase the retention rate of women in computing disciplines. Comparison of retention rates of women participating in the internship program and non-intern women will be collected over the 5-year study period. Data is being collected on the retention of the females entering the CIS program beginning fall of 1999 to make comparisons between the females in the internship program and students not in the program. Thus far, the participation level and duration are insufficient to draw any statistically significant conclusions. However, several decisions have been made relating to the selection and placement of the early-entrance interns. *All interns* must have adequate preparation for success in the discipline. A minimum requirement should be a respectable score on the math ACT or equivalent and a 3.0 of 4.0 high school grade point average. Since resources are thin, careful screening of students for placement in special programs for retention and recruitment is fiscally prudent. In most cases, if a student lacks the prerequisite knowledge and problem-solving training, it will take much more than an internship to retain that student.

The placement of the early entrance interns in the program is also critical. An intern position that is above the level of the intern's technical training will have a negative affect on the student's confidence. The loss of three females due to poor performance was attributed to inappropriate placement. The coordinator accepts the responsibility of allowing an industry manager to select an early-entrance intern to a position for which the coordinator felt the student was not prepared. The coordinator overestimated the support provided to the intern by the industry environment. Appropriate position selection for early-entrance interns is critical for success. Unfortunately, in practice, few appropriate positions actually exist. Currently, there are more early entrance qualified intern applicants than appropriate positions. Therefore, this is an area where the university will work closely with industry to identify and create additional opportunities.

The goal of the longitudinal study is to compare the graduation rates of women participating in the internship program to the non-participating women in the CIS major. The plan for the program is to continue to integrate early entrance females into the internship program and track their progress relative to other students, both male and female. The first statistical analysis will be completed after the group, entered in Fall 1999, has had a sufficient time to graduate, Summer 2004.

SUMMARY

The progress toward increasing the retention of women in CIS has been slow and discouraging. We have learned that affecting retention is not a short-term process; it takes years to reach a significant momentum. Antidotal data indicates an increased awareness of the need for women in the discipline by both faculty and students. Both groups are expressing an increased interest in expanding sensitivity and education about the problem, and taking advantage of the resources provided. More women are inquiring about the women in computing support and service opportunities and more women are actively participating in on-campus discipline-related activities—attending and organizing guest speaker presentations, holding ACM and ACM-W officer positions, etc. The plan is to continue to increase the number of early entrance interns and collect sufficient data about attrition rates to draw appropriate conclusions.

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