Encouraging Undergraduate Women In Computing: A Preliminary Study

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Abstract

This paper reports the results of a preliminary study that introduced a first-year general studies seminar designed to encourage interested women to rise above the obstacles to a computing major. The literature informed the design of the course's structure and content. The literature suggests that women need a more realistic perception of computing as an area of study and work. Women need more experience to develop their interest in computing and to enhance their computer skill confidence. Women would benefit from a collaborative learning environment. While the students in this course did not change, significantly, their computer attitudes, they improved their perceptions of their computer skill proficiency in several areas.

Keywords: Undergraduate, women, women-education, computer science, computing, attitudes

1. INTRODUCTION

Although new core information technology (IT) jobs are expected to increase between 1998 and 2008 (Office of Technology Policy 2000), the number of students awarded computer and information science degrees declined steadily from 1986 to 1994 with a only a slight increase between 1993 and 1996 (Meares and Sargent 1999; Office of Technology Policy 1997). Three-fourths of these new IT jobs will require a bachelor's degree (Office of Technology Policy 2000).

Women will be needed to fill new IT jobs (Camp 1997; Devoe 1998; Gaudin 1999). While women are more likely to enroll in college than men are, they are a significantly underrepresented percentage of the population earning computer science degrees (Camp 1997; National Science Foundation 2000). The question for higher education is how to attract and retain women in computing degree programs (Bernstein 1997a, 1997b; Scragg and Smith 1998). As an intervention strategy, several authors have suggested providing an introductory course to lay the foundation for future study and to help women overcome their special barriers to computing (Bernstein 1997a, 1997b; Davis and Rosser 1996; Sackrowitz and Parelius 1996).

This paper reports the results of a preliminary study that introduced a course designed to encourage undergraduate women to rise above the obstacles to a computing major. This study has the following objectives:

1. To raise the self-perceived computer skill level of first-year women students who are computing majors or who want to explore the option of a computing major or minor, and
2. To influence these women to have more positive attitudes toward computing.

2. WOMEN'S OBSTACLES TO COMPUTING

The National Science Foundation (2000) reports that women earned 47% of all bachelor's degrees awarded in science and engineering (S&E) between 1966 and 1996. In this same period, the share of degrees awarded to women increased in every S&E field except mathematics and computer science. Women's proportion of computer science degrees decreased from a high of 37% in 1984 to a low of 28% in 1996, the last year reported.

Women face several barriers to choosing and being successful in computing degree programs. The following sections describe a few of those obstacles.

Perceptions of Computing as an Area of Study and Work

To encourage gender equity, Fisher, Margolis, and Miller (1997) suggest, "If we can dispel the perceptions of most CS students being immature males who burrow into their computers for all forms of satisfaction, there is hope" (p. 109). Women appear to be deterred from pursuing computer science because of the conception that it consists of nothing but programming and technical issues (Fisher, Margolis, and Miller 1997). Clegg and Trayhurn (1999) conclude that women view themselves capable of pursuing computing careers and are knowledgeable about the associated rewards, but often choose careers that they perceive will offer them more social interaction.

Involvement with Computers

Fisher, Margolis, and Miller (1997) argue that, women's attraction to computing may be an evolutionary process that requires time to develop. In the words of Bernstein (1991), "The greatest predictor of success with computers is prior exposure: mucking about and experimenting" (p. 102). In a study of first-year undergraduate computer science students at Carnegie Mellon University, the females ranked class experiences as one of the most important reasons for their choice of major (Fisher, Margolis, and Miller 1997). Women in this study expressed more interest and confidence in computing, as they became more comfortable with the course work and the department

Because women often have weaker formal and informal computer experiences than men, they have difficulty in the introductory programming course (Fisher, Margolis, and Miller 1997; Sackrowitz and Parelius 1996). In the area of computing, Fisher, Margolis, and Miller (1997) found a gap between women's actual performance and their perceptions about their ability. Several authors call for either a change in the first programming course or an additional course to attract and to retain more women in computer science (Bernstein 1997a, 1997b; Fisher, Margolis, and Miller 1997; Sackrowitz and Parelius 1996).

> …the colleges must make efforts to adjust the pace and/or structure of the introductory course to ensure that a student with an aptitude for computer science but little computer science background can have a reasonable chance for success. Appropriate changes would help women gain more skill and confidence with computers and thus encourage more women to pursue a computer science major (Sackrowitz and Parelius 1996, p.40).

Climate and Pedagogy

After observing the importance of peer group learning experiences to the persistence of math, engineering, and science majors, Seymour and Hewitt (1997) concluded that its "formal incorporation into the curriculum and pedagogy of basic classes clearly offers one of the most immediately-available, cost-effective ways to increase persistence" (p. 177). Post-secondary computing courses, however, typically are consistent with the traditional male model that encourages competition and individualism (Clark and Teague 1994). In a study across different institutions, McGrath Cohoon (1999), found that computer science departments varied in their attrition rates by gender. She suggested that pedagogical techniques could be one departmental characteristic that might affect gendered attrition rates.

Clarke & Teague (1994) argue that a laboratory-based, group-work teaching style in computing courses is more appropriate for female students. They suggest that lecture be replaced with a scheduled laboratory where students work in small groups with the direction and assistance of an instructor to achieve group success on structured assignments. Schuh (1996) found that the instructor helped reduce students' computer anxiety by providing requested guidance.

> Environments that provide scaffolding so that participants can acquire new skills, encourage sharing of ideas so that learners can make realistic appraisals of their own contributions, and provide extensive feedback and encouragement so that learners can recognize their own strengths, may well increase persistence among those who are less confident (Linn and Hyde 1989, pp. 25-26).

3. COURSE DESCRIPTION

During the fall semester of 2000, Richard Stockton College of New Jersey offered a general studies, first-year seminar that was described in registration material as being designed to provide an avenue for women to explore the possibility of a major or minor in computer science and information systems (CSIS). Richard Stockton College is a four-year institution, with six small professionally oriented masters programs, that mostly serves southern New Jersey. In the fall semester of 2000, 6300 students were enrolled. Fifty-four of those students were first-year students who indicated an intention to major in CSIS; 11 of those 54 were women.

The literature informed the design of the course's structure and content. The literature suggests that women need a more realistic perception of computing as an area of study and work (Clegg and Trayhurn 1999; Fisher, Margolis, and Miller 1997). Women need more experience to develop their interest in computers and to enhance their computer skill confidence (Fisher, Margolis, and Miller 1997; Bernstein 1991). Women would benefit from a collaborative learning environment (Clarke and Teague 1994; Linn and Hyde 1989; McGrath Cohoon 1999; Schuh 1996; Seymour and Hewitt 1997). Students were expected to gain hands-on experience with some of the tools in the college's computing learning environment, to explore computing occupations and the special challenges of women in computing through research and interaction with women currently in the information technology workforce, and to develop collaborative learning relationships with other class members.

The class structure included a computer laboratory component, a regular classroom component, a computer conferencing component, and a research component. The instructor for all components was the same female professor. Twice weekly, the class met in the computer laboratory in a collaborative environment to explore the college's computing learning environment. Students worked on structured assignments involving word processing, spreadsheets, presentation software, the Internet, the college's virtual library, e-mail, computer conferencing, and web page fundamentals. Students were encouraged to work together and to ask the teacher for guidance.

The other components encouraged students to explore topics that would increase their knowledge about computers, about women's special barriers to entering IT workforce, or about careers in IT. During the weekly classroom session, for example, women guest speakers discussed gender bias in public schools, their duties as IT workers, and their IT career paths. In one session, senior women described their own experiences as CSIS majors.

Each week, students were required to post a short summary of a reading about women and computing issues on the college's computer conferencing system. Students were encouraged to work together in their research by sharing appropriate articles, books, and web sites. Those readings helped students search for a topic for a required research paper. At the end of the semester, students used presentation software in an electronic classroom to present the outcome of their research.

4. METHODOLOGY

To determine if students perceptions of their computer skill levels or their attitudes toward computing changed from the beginning to the end of the course, two surveys were administered to the students: the *Computer Attitude Survey* (CAS) (Gardner, Discenza, and Dukes 1993; Loyd and Gressard 1984; Schuh 1996) and a portion of the *Multimedia Teaching Questionnaire* (MTQ) (McKeachie and Velayo 1994). Both instruments are Likert type questionnaires. During the first two weeks of the semester, students anonymously completed the CAS and the MTQ (Pretest). In the last two weeks, the CAS and the MTQ (Posttest) were administered.

The CAS is a 40 question instrument that measures four types of self-reported attitudes on a scale from one to four: "(a) anxiety or fear of computers; (b) liking of computers or enjoying working with computers; and (c) confidence in ability to use or learn about computers" (Loyd and Gressard 1984, p. 502), and (d) viewing computers as useful (Schuh 1996). Scores on the 10 questions in each subscale are summed for a subscale score. Then, the four subscale scores are added to produce a total computer attitude score. Higher scores represent attitudes that are more positive.
The portion of the MTQ (Pretest and Posttest) that was administered allowed the respondents to report their perceptions of their computer skill proficiency in eight different areas: word processing, database, communications, spreadsheet/graphics, drawing/painting, presentation, web page authoring, and computer conferencing. The scale ranged from a low rating of proficiency of one to a high of six.

In the case of each survey, paired t-tests were performed to explore the possibility of mean differences in computer attitudes or in perceptions of computer skill proficiency from the beginning to the end of the semester. In each paired t-test, the difference used is the posttest score minus the pretest score. The alpha level is 0.05.

5. FINDINGS

Twenty first-year students enrolled in this bridge course that was a first-year seminar designed for women who wished to explore the possibility of a major or minor in computing. Because men were not restricted from enrolling in the course, three of the students were men. Eighteen students completed the CAS survey at both the beginning and at the end of the semester. Seventeen students completed the MTQ pretest and posttest. Seven students indicated computing as their first choice for a major. Computing was a second choice major for three other students.

Computer Attitudes

Analysis of the CAS surveys revealed no significant difference between the means of computer attitudes of students from the beginning to the end of the semester. Table 1 presents the results of the paired t-tests for the CAS data. The means of the pretest scores demonstrate that computer attitudes of the students at the start of the semester were very positive. Students' perceptions that computers are useful (Pre Usefulness), is the highest pretest mean, 37.333; students' perceptions that they like to work with computers (Pre Liking) is the lowest, 31.44. While the differences are not significant, posttest means in all areas except perceptions of computer usefulness (Post Useful) are higher than pretest means.

Perceptions of Computer Skill Proficiency

While the students' computer attitudes did not change significantly during the semester, students' perceptions of their computer skill proficiency increased significantly in five of the areas measured by the MTQ: web page authoring, presentation, drawing/painting, computer conferencing, and spreadsheet/graphics. The results of the paired t-tests performed on the MTQ data are shown in Table 2 by decreasing size of the mean difference between posttest and pretest scores. At the beginning of the semester, students' mean ratings of their computer skill proficiency in order from highest to lowest are communications (5.059), word processing (4.941), computer conferencing (4.235), presentation (3.647), spreadsheet/graphics (3.412), drawing/painting (3.294), database (3.176), and web page authoring (2.472). By the end of the semester, the means of the students' proficiency ratings were above four, out of a possible six, in every computer skill area except database.

Table 1: Computer Attitudes

	N	Mean	StDev	SE Mean
Post Usefulness	18	36.944	3.811	0.898
Pre Usefulness	18	37.333	3.049	0.719
Difference	18	-0.389	2.524	0.595
P-value = 0.595				
Post Confidence	18	36.5	4.048	0.954
Pre Confidence	18	35.611	3.837	0.904
	18	0.889	3.123	0.736
P-value = 0.244				
Post Anxiety	18	36.00	5.29	1.25
Pre Anxiety	18	35.11	4.75	1.12
Difference	18	0.89	4.43	1.04
P-value = 0.302				
Post Liking	18	32.67	6.33	1.49
Pre Liking	18	31.44	5.03	1.19
Difference	18	1.22	3.889	0.917
P-value = 0.200				
Post Total	18	142.11	17.78	4.19
Pre Total	18	139.50	13.95	3.29
P-value = 0.302	18	2.61	10.40	2.45

Table 2: Perceptions of Computer Skill Proficiency

	N	Mean	StDev	SE Mean
Post Web	17	4.882	0.600	0.146
Pre Web	17	2.472	1.419	0.344
Difference	17	2.412	1.622	0.394
P-value = 0.000				
Post Presentation	17	5.000	1.000	0.243
Pre Presentation	17	3.647	1.656	0.402
Difference	17	1.353	1.656	0.402
P-value = 0.004				
Post Drawing	17	4.294	1.404	0.340
Pre Drawing	17	3.294	1.404	0.340
Difference	17	1.000	1.225	0.297
P-value = 0.004				
Post Conference	17	5.176	0.728	0.176
Pre Conference	17	4.235	1.437	0.349
Difference	17	0.941	1.435	0.348
P-value = 0.016				
Post Spreadsheet	17	4.294	1.047	0.254
Pre Spreadsheet	17	3.412	1.228	0.298
Difference	17	0.882	1.111	0.270
P-value = 0.005				
Post Database	17	3.471	1.281	0.311
Pre Database	17	3.176	1.185	0.287
Difference	17	0.294	1.047	0.254
P-value = 0.264				
Post Comm	17	5.353	0.702	0.170
Pre Comm	17	5.059	1.088	0.264
Difference	17	0.294	0.849	0.206
P-value = 0.172				
Post Word process	17	5.118	0.600	0.146
Pre Word process	17	4.941	1.144	0.277
Difference	17	0.176	1.131	0.274
P-value = 0.529				

6. CONCLUSIONS

Students' computer attitudes did not change, significantly, during the semester. This lack of change may have resulted from the fact that the students self-selected to be in this course. At the beginning of the semester, the group already had very positive attitudes toward computing; they also had previous experience working with computers. It is interesting to note that the mean on liking to work with computers (Liking) was the least positive of all the subscale scores. This result is consistent with Clegg and Trayhurn's (1999) conclusion that women view themselves as capable of pursuing computing careers and understand the rewards of such a career, but that they often choose other fields.

Student-perceived computer skill proficiency increased in all areas except communications, word processing, and database. Web page authoring showed the greatest improvement in proficiency. These results possibly can be explained by the students' previous experience and by the course content. At the beginning of the semester, students indicated that they mostly had a high level of proficiency in communications (5.059) and word processing (4.941). The course covered only the fundamentals in those two areas so not much improvement could be expected. Beginning perceptions of their database proficiency was much lower (3.176). Database was not included in the course topics. The web page authoring subscale had the lowest mean score (2.472) at the beginning of the semester. Almost half of the computer laboratories involved web page authoring so students had the opportunity to increase their skill levels in this area. These measures are self-reported and, thus, may not reflect a true increase in student's skill levels.

This study will continue to track the progress of students in the first offering of this first-year seminar and of students who take this course in successive years. Because of this analysis, the next offering of this first-year seminar will include less word processing covered at a faster pace to allow time for a gentle introduction to programming.

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