# The More Things Change, the More they Remain the Same: Gender Differences in Attitudes and Experiences Related to Computing Among Students in Computer Science and Applied Information Technology Programs at five U.S. Research Universities*


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*Introduction*

A number of studies have addressed the problem of women's shrinking representation in computer science programs at the undergraduate and graduate levels (Cohoon, 2001; Creamer, Burger, and Meszaros, 2004; Bryant and Irwin, 2001; Margolis and Fisher, 2002; Moorman and Johnson, 2003). These studies and others document the problems and try to address the causes. Some studies propose and implement solutions (Margolis and Fisher, 2002; Lee, 2002; Natale, 2002; Beyer et al., 2003; Chavez and Rynes, 2003). All of this research focuses predominantly on educational programs or employment in the field of computer science specifically, rather than examining the trends in information technology defined more broadly.

We report on a study comparing the demographics, attitudes, and computing-related behaviors of undergraduate and graduate students majoring in computer science with those majoring in other information technology disciplines.

As Berghel and Sallach's (2004) research illustrates, the trend in universities where computing is being taught is toward merger with other departments or schools in which applied forms of information technology are being taught. Those units include (but are not limited to) information systems (traditionally found in business schools); instructional technology (traditionally found in schools of education); information science (traditionally combined with library science); and the newest discipline, informatics (generally thought of as a set of disciplines at the intersection of people, technology and information). Berghel and Sallach go so far as to call this a paradigm shift in the reorganization of academic instruction in computing and information technology on campuses across the country. Further, they say that the "breadth and diversity of subject areas [in the new schools and colleges] suggests that the process of computer information technology program evolution has yet to slow down or stabilize" (p. 84).

This trend is potentially important to expanding the educational involvement of women as they are more likely to have parity or near parity with men in certain disciplines, such as library and information science and education (Quint, 1999; Wolverton, 1999). These units traditionally have histories of recruiting and retaining larger numbers of women. Though programs targeted at women in computer science, like the one at Carnegie Mellon (Margolis and Fisher, 2002), have illustrated that attention to problems within the discipline can result in increased recruitment and retention of women, lessons might also be learned by examining the differences between the characteristics of the students, the nature of the programs, and the institutional climate in the related information technology disciplines. As we have previously pointed out (Ahuja et al., 2004), students in these applied fields are grounded in the contexts of real world problems; study in a more gender-balanced environment; and may experience a more woman-friendly culture.

Among the findings that emerge repeatedly from previous research is that girls and women are less likely to choose computing as a career in the first place, for reasons that have been traced variously to lack of aptitude, interest, or experience regarding computers, on the one hand (Badagliocco, 1990; Kramer and Lehman, 1990; Young, 2000), and to cultural stereotypes and perceptions that computing is a mostly masculine activity, on the other (Kiesler, Sproull, and Eccles, 1985: Turkle, 1988). If few women opt to study IT, efforts to make IT education more women-friendly can have a limited effect, at best. The question arises, therefore, whether applied IT careers attract more women, and, more generally, what kind of students enroll in applied IT programs, as compared to computer science programs. Answering this question is an important first step in understanding the potential of new, interdisciplinary, applied IT disciplines to foster more equitable outcomes for women in computing technology fields.

The research question for this part of a larger study of educational experiences and the institutional culture of information technology education is as follows: Are there significant differences in the demographics, computing experiences and behaviors, and attitudes toward computing between undergraduate and graduate students studying computer science and students studying information technology in some other applied discipline in the university? Because the information technology disciplines being studied involve elements of computer science, it is possible that the male-dominated culture will be represented in these units. This study was designed to determine whether that has happened.

***Method***

As part of a larger study of departments and schools where information technology is taught [including computer science (CS), management information systems (MIS), informatics (I), instructional systems technology (IST) and information science/studies (IS)] in five U.S. research institutions, we conducted a web-based survey of all male and female undergraduate and graduate students in those units. The universities included: Indiana University Bloomington, University at Buffalo (formerly SUNY-Buffalo), University of Illinois at Urbana/Champaign, University of Michigan at Ann Arbor and Dearborn, and University of Washington. These publicly funded institutions were selected based on the minimum requirement of having a computer science unit and at least two other IT-related units. We also gave preference to institutions with programs in instructional technology and/or informatics because these are relatively less common.

The survey was conducted in March and April 2004 by the Center for Survey Research at Indiana University. We selected a web-based format for the survey because information technology students would be most comfortable with this format. Response rates have been found to be roughly equal for Web surveys and mail surveys (Truell, Barlett, and Alexander, 2002). The majority of students were contacted directly through their university e-mail accounts. For reasons of student privacy, students in three units were contacted through an administrator in their unit via e-mail. Students answered 100 questions related to their attitudes and behaviors regarding use of computers, demographic information, information about mentoring, stress and burnout. Only part of the data from the survey will be addressed in this chapter. It was not possible to determine total response rate because we were not informed of the number of students in the units where the administrator made first contact with the students. Response rates for the rest of the students ranged from 32% to 85% by academic unit[1]. Though the total number of respondents was 1768, the number we will use to report the results for this chapter is 1516. The remainder of the surveys did not respond to the question asking for their gender. Results were analyzed through SPSS 11.

[1] Though these response rates are lower than we would have liked, they are not unusual for web-based surveys. Because we did not conduct a random sample survey, however, we make no claims at representativeness of this study. We present the results of the survey for what it is—responses from students in information technology programs at five research universities in the United States. We believe, however, that these responses are not atypical for most students studying in information technology programs in the United States.

### *Analysis*

To assess the differences in gender by type of program, we split the sample, placing all computer science (CS) students in one group and all the rest of the students from applied information technology disciplines (Applied) in another. In the CS group, a total of 508 males and 115 females completed the survey while in the Applied group, a total of 414 males and 479 females did so. The proportions of responses by gender are in keeping with what we expected—a higher proportion of women in the applied IT units. In three of the units where library and information science is the focus of study about twice as many women responded to the survey as did men. The primary analysis tools were crosstabulations of the data by type of program (computer science or applied information technology) with the variables in question (discussed below). We also used factor analysis to determine which variables could be used together tapping similar dimensions. Simple frequencies are also reported in the analysis. When those are used, we have not applied any statistical comparisons.

Demographics

The sample was skewed more towards undergraduate students in the CS part of the sample (57.0% vs. 23.0% of the Applied sample). Master's students made up 12.8% of CS students and 65.2% of the Applied students. Doctoral students comprised 30.2% of the CS students and 11.8% of the Applied students. When year in school was broken down by gender, interesting patterns emerged as shown in Table 1. CS students are predominantly undergraduates (56.9%), but the next largest category is doctoral students. The Applied units tend to have the most students in the master's category (65.5%), with undergraduates coming in second (22.9%). There are several reasons why the distributions differ. In computer science, students who come to graduate school are primarily seeking a doctorate and may acquire a master's degree along the way, but the master's degree is not the main goal of most graduate computer science students. The goal of these students is more frequently a career in academia where the doctorate is the minimum requirement. In the Applied fields, the professional master's degree is highly valued for students who seek jobs in industry. Some schools where library and information science is taught do not even offer undergraduate degrees (two in our sample).

The distribution of males and females in the applied units also varies with many more women enrolled in the master's degree programs than men (77.8% vs. 51.4%). Most of this difference is accounted for by the large enrollments of women in units where library and information science is taught and especially, in courses of study related to library science. Seventy-nine percent of library science students and 82% of librarians are female, according to a 2002 report (Maata, 2003). Though there are fewer numbers of women in the doctoral programs at the PhD level (13.5% vs. 10.0%), the differences are not significant. At the undergraduate level in the Applied units, men are almost three times as prevalent as women (35.2% vs. 12.2%). These differences show up primarily in units where informatics or information systems is the focus.

In terms of age, the CS students fit a more traditional age pattern, while the Applied students tend to be older (See Table 2). Almost all of the CS students, including those in the doctoral program, are under the age of 35. In the Applied schools, however, 27.5% of the total number of people responding to the question asking when they were born, were age 35 and over, and 11.1% of those students were age 45 or more. The high numbers of students of non-traditional age obviously impacts the results of this study, particularly in those students' attitudes and experiences related to computing.

Other demographic patterns are consistent with the age and year-in-school data. Of those who said they live with a spouse or domestic partner, 75% were students in Applied programs. In CS, 95 men and 24 women reported living with a spouse or domestic partner, while 203 women and 155 men in the Applied group reported doing so. In the CS group of students only 25 men and 3 women said they had any children living in their households.  Again, in the Applied group many more of the men (65) and women (85) said they had children in their homes.

We also asked whether respondents were currently employed. Since the survey was administered during the school year, answering that question in the affirmative would mean that they were employed while studying. In the CS group, 277 (54.5%) men and 66 (57.4%) women said they were employed, while 321 (77.5%) men and 398 (83.1%) women on the Applied group reported current employment.  The high percentages of both men and women reporting employment in the Applied group is also an indicator of their non-traditional student status. But it impacts the time available to be spent on their studies and pursuing extracurricular activities related to their majors.

Some other studies have found a relationship between parents' careers and socioeconomic status and the field of study chosen by their children (Tilleczek and Lewko, 2001; Shashaani, 1994) In our survey whether or not the father was employed in an information technology field was not significantly different for men and women in either the CS or Applied groups.   However, more women in the CS group  (4.5% of men vs. 13.2% of women) reported having mothers who worked in an IT field than did men in

CS (Phi=.14; p=.002). An equal percentage of men and women in the Applied group (4.6%) reported having a mother who worked in IT. (4.6%)

We asked questions about whether respondents' fathers and mothers held traditional views about the roles men and women should adopt—for example that men should be the primary wage earners and women should be the primary child care providers in the home. Though the responses to these questions do not qualify as demographic information, it is important to provide the results based on those questions here as they may be related to the age and year-in-school distribution . For both the CS and Applied groups we found gender differences for the fathers' views. Men tended to have fathers with more traditional views than did women (Phi=.09; p=.01 for Applied and Phi=.10; p=.03 for CS). However, the difference was only significant for CS students when it came to reporting on their mothers' views, with a higher percentage of men in the CS group reporting their mothers had traditional views (Phi=.11; p=.01)[2]. Stated differently, more women in computer science reported that their mothers did not hold traditional views than the men in those units did. This finding is consistent with Shashaani's finding (1994) that children's attitudes related to computers often follow from the gendered views of their parents regarding appropriate sex roles in the field of computing.

[2] Because this study is not based on a random sample of students in the selected academic units, we cannot report sampling error when percentages are given. However, we do report statistical significance levels as a way of understanding the importance and the degree of difference between groups and between males and females for the variables in this research.

Computer Experiences

Though earlier studies found that men used computers at younger ages than did women (Badagliacco, 1990), more recent studies have found no age differences (Beyer, Chavez, and Rynes, 2002; Beyer, Rynes, Chavez, Hay, and Perrault, 2003; Colley and Comber, 2003). This is to be expected as PC household penetration rates have been steadily increasing from the time of the PC’s inception in the early 1980s particularly among higher SES households (U.S. Department of Commerce, 2000; U.S. Census Bureau, 2001). In this study, however, men in both CS and Applied groups tended to begin using computers earlier than women did (See Table 3). However, when we compared men and women across units we found that men in the Applied units were much more likely to learn earlier and on their own while women learned later and through school or other organized instruction (Kendall’s tau-c<.21; p<.000). The difference was also significant for the CS group, however (Kendall’s tau-c<.08; p<.04). The surprise in this finding is that a difference persists in the CS group where men and women in this traditional age group have had the opportunity to work with computers most of their lives, while the high percentage of older students in the Applied group would partially explain the difference in age of exposure and opportunity.

When we asked about game-playing activity when the respondents were children, much higher frequencies were reported by computer science majors than by the applied group majors. Moreover, also consistent with previous research (Fromme, 2003; Oosterwegel, Littleton, and Light, 2004), the males in both groups reported more computer game playing than the females (Kendall’s tau-c=.36; p<.00 for CS and Kendall’s tau-c=.18; p<.000 for Applied). From ages 12-17 the main activity reported by men in the CS group was games (48.2% vs. 38.8% of the men in the Applied group). For women in CS, the most popular activity was communicating with friends (32.7% vs. 14.4% of women in the Applied group). Perhaps more important than the variety of activities each group mentioned was the finding that men and women in both groups chose different activities (Cramer's V=.28; p=.000 for the CS group and Cramer's V=.28; p=.000 for the Applied group). The largest percentage of women in the Applied group chose the "other" category (45.2%). We asked respondents to specify what they meant by "other." Because so many of this group were born and grew up in the time before the PC was available, a majority of the respondents who cited "other" said they didn't have a computer and had no exposure to a computer when they were age12-17.

A similar kind of response came from the Applied group when we asked when they learned to program a computer. In the Applied group, 15.2% of the respondents said they didn't know how to program. We were not surprised by that because many students in applied programs may work only with computer applications. The older students in these programs who did not know how to program likely also hadn't learned programming skills in their current course of study. No CS student declared a lack of programming knowledge. Of the respondents who answered with one of the fixed choices, men in both groups tended to learn at younger ages and more on their own than in structured environments (See Table 3). The differences between the place and time men and women learned to program was significant for both groups (Cramer's V=.29; p=.000 for Applied and Cramer's V=.28; p=.000 for CS).

Reasons for Choosing IT

People choose their careers in a variety of ways. Often the choice is attributed to some person who served as an inspiration. We asked respondents to identify individuals—parents, teachers, employers, friends, spouses, etc. by gender as the primary individual who encouraged them to study information technology. Of those who identified someone, men were identified more often by males and females were more often identified by women for both groups. However, the differences were greater for the Applied group than for the CS group (Cramer's V=.33; p=.000 for Applied and Cramer's V=.19; p=.000 for CS). (See Table 4) A few variations between groups are interesting to note. Students' fathers seemed to be much stronger influences for both male and female CS students (21.0% for men and 27.2% for women) than they were for the Applied group (12.1% for men and 7.1% for women). This finding is consistent with that of the survey of Systers' members by Turner et al. (2002) in which women working in IT careers who majored in computer science or information systems as undergraduates said their parents, and particularly their fathers, were influential in making the decision. Sashaani (1994) also found that parental encouragement positively affected children's attitudes related to computing. About half of all students in the Applied group and half of the men in the CS group said that nobody had encouraged them to study information technology. However, only one-fourth of the women in CS said that nobody encouraged them.

We also explored reasons why the students had chosen their particular information technology field of study to determine if there were gender differences and differences between students in CS or Applied fields. Questions about various aspects of the nature of IT work were placed on a four point scale as to level of importance from not at all important to very important. In today's job market, finding well-paid employment is one of the central issues in choosing a career. The students in this study were no exception. Of the Applied group 82% of the respondents said that finding well-paid employment was either a somewhat or very important factor. There were no differences between men and women in their responses. CS students also counted salary as important, but in this case the men placed slightly more emphasis on this as a factor in choosing information technology than did women (Kendall's tau-c=.07; p=.03). Other factors that men and women in both the Applied and CS groups found equally important were having a flexible work schedule, and the challenge inherent in the subject matter.

Having a personal interest in the subject matter was given high priority by both groups, with 78.9% of the men in the CS group rating it "very important. " There were no differences between men and women in the Applied group on this factor, but women in the CS group rated this factor significantly lower than men did (Kendall's tau-c=-.11; p=.001). This may be an area for further exploration if these women decide not to persist to graduation in computer science.

Men and women are known to have different levels of interest in helping others as part of their life's work (Creamer et al., 2004), but when we asked this question of the CS group, there were no gender differences. Only 12.7% of men and 15.8% of women said that helping others was a "very important" factor in majoring in an IT field. This is not particularly surprising as helping others is not generally thought of as a characteristic of work in computer science (Bentson, 2000). But differences did show up in the Applied group (Kendall's tau-c=.14; p=.000) with women expressing significantly more interest in this factor. Because the Applied group includes a fairly wide range of potential career paths, it is possible that several of those might include jobs where helping others is part of the description.

Role models often inspire people to adopt a particular course of study. Technology adoption research has found that women are more likely than men to start using a new technology because people they like and respect are doing so (Venkatesh and Morris, 2000) In our study about four out of ten men and women students in the CS group responded that they were studying information technology because the people they admired and respected are studying or working in this field. Men said this factor was either "somewhat important" or "very important" a little less often than did women in CS (38.5% vs. 43.9%), but this difference was not significant. However, the difference on this factor for men and women in the Applied group was significant (Kendall's tau-c=.11; p=.003). Women in the Applied group were more likely to say they were drawn to the field because of the people they admired and respected than men in this group.

We expected that a person's perceived skill in a discipline would be a very important factor for selecting a major. There were significant differences between men and women in both the CS and Applied groups on this factor. One question asked how important the statement "I've always been good with computers" was in making the decision to major in IT. Men were much more likely to say that this was somewhat or very important than were women (84.7% of men and 66.0% of women in CS; and 72.9% of men and 53.0% of women in Applied fields) (Kendall's tau-c=-.18; p=.000 for CS; Kendall's tau-c=-.28; p=.000 for Applied). We emphasize that this variable measures the student's perception of his or her skill with computers, not the actual skill. However, previous research (McCoy and Heafner, 2004; Young, 2000; Herring, 1993)) has found that women tend to rate their computer skills lower than do men. And the question relates to the relative importance this factor had in deciding on a major. However, since the question did not ask them directly about their perceived computer skill, it may be that women believe their skills are just as good as those of the men but that the skill level was not so important in attracting them to IT. However, that conclusion is found not to be valid in the analysis of the variables in the computer attitudes section below.

The series of questions about choice of major was followed by a question about respondents' relative satisfaction with the decision to major in an IT field. Overall both groups were quite satisfied with their majors. Only 41 of the Applied group and 55 in the CS group said they were somewhat dissatisfied or very dissatisfied with their decision. Further, men and women in both groups were equally satisfied with the choice they had made. Women in the CS group were a little less satisfied than men in that group but the difference was only close to being significant (p=.06). However, when we asked respondents how confident they are that they will complete their current degree program, differences between groups (and not between gender within a group) appeared. Overall, students in the Applied group expressed higher confidence that they will complete their degrees (Kendall's tau-c=.12, p=.000). In the Applied group, about 87% of the men and 91% of the women were very confident of degree completion, while in the CS group 77% of men and 76% of women expressed that level of confidence.

Attitudes about Computer Work

We asked a battery of questions used in previous surveys regarding individuals' skills, efficacy, comfort, and use of computers. Previous studies have found that women are more likely to have less confidence and comfort levels than men (Compeau et al., Higgins, and Huff, 1999; Durndell and Haag, 2002; Lee, 2002). But Oosterwegel et al. (2004) found that both boys and girls who had images of themselves as skilled with computers were less likely to express doubts about their computer efficacy

> . . . the results indicated no overall sex difference in “actual vs. ideal” self-perception in relation to computer games or tasks. Nor were there overall sex differences in children’s aspirations to be good with computers. However, the boys saw themselves as better with computer games than with school-type ICT tasks, whereas the reverse was true for girls. Individual boy respondents saw themselves as very different to girls (more so than individual girls saw themselves as different to boys) whether in general or in relation to computer games and tasks. Boys and girls were considered to be more different from one another with regard to computer games than either on ICT tasks or in general . (Oosterwegel et al., 2004, p. 225).

In our survey we should not have observed much distance between respondents’ personal evaluation of how good they are with computers and their levels of confidence and comfort with computers because both men and women in this survey had chosen majors that required working with computers. However, that was not the case.

Comfort levels with computers were much higher for men than for women. That was true of both the CS group and the Applied group (Kendall’s tau-c=.22 for Applied, p=.000 ; Kendall’s tau-c=.19 for CS, p=.000). In both groups about half of the women said they were “very comfortable” using computers, but 86% of men in CS and 77.3% of men in the Applied group expressed that level of comfort. A related question asked how comfortable the respondent felt when trying new things on the computer. Gender differences emerged again for both groups, though the difference was larger for the Applied group (Kendall’s tau-c=.20, p=.000 for Applied; Kendall’s tau-c=.11, p=.000 for CS). It was surprising that even in the CS group, 5.2% of women said they were “not too comfortable" trying new things on the computer while none of the men in the CS group expressed that view.

Self confidence levels with computers, a related concept to comfort with computers, were also lower for women than for men in both groups. In the CS group, 13.1% of the women vs. 2.6% of the men said they were "not very confident" or "not at all confident" when working with computers. In the Applied group the confidence gap was also large, with 3.1% of men and 11.3% of women responding in those categories. The differences in both groups were significant (Kendall's tau-c=31, p<.000 for Applied; Kendall's tau-c=.25, p<.000) for CS.

Given the gender gap in comfort and confidence, we expected that when the students were asked to rate their computer skills and their grades in programming classes compared to those of their classmates, the women would rate themselves lower than the men. The men in CS rated their skills at the highest levels, as "better" or "much better " than others in their major (67.1% of the group), while the women in the Applied group rated their skills the lowest (24.0% rated their skills as "better" or "much better"). The same level of gender difference emerged for both groups, however (Kendall's tau-c=.24, p<.000 for CS and Applied). Of course we have no way of knowing what grades either group actually received. It is entirely possible that women only think their grades are lower than those of their classmates.

Differences between men and women also appeared in their reported ease at learning new programming languages. Of those respondents who have learned programming, men in both CS and Applied groups reported they learn new computer languages more easily than women said they learned those languages (Kendall's tau-c

=.15; p=.04 for the Applied group and Kendall's tau-c=.11, p=.03 for the CS group). Similarly, more men reported getting high grades in programming classes, but the difference was significant only in the CS group (Kendall's tau-c=..10, p=.01).

Finally, we addressed students' perceived interest and engagement in addressing problems they encounter in the course of their work on computers. First we asked the degree of appeal the challenge of solving problems with computers had for them. Men in both the CS and Applied group expressed a higher attraction to this challenge (Kendall's tau-c=.19, p=.000 for the Applied group; and Kendall's tau-c=.08, p=.01 for the CS group). The difference was smaller for the CS group, however, with 4% of the men and 2.6% of women saying the challenge was not at all appealing. Overall, men in the Applied group said they liked to spend more of their free time on the computer than women (Kendall's tau-c=.11, p=.002), but men and women in the CS group said they like to spend about the same amount of their free time with computers (in gaming or other activities). But when it came to interest in black box issues, men were more likely in both groups to say that they were interested in understanding how computers work (Kendall's tau-c=.22, p=.000 for the Applied group; and Kendall's tau-c=.10, p=.002 for the CS group).

The persistence issue was approached through a question that asked how likely it was that the respondent would stick with a problem with a computer program that could not be immediately solved. In both groups, men expressed greater willingness to stick with the problem (Kendall's tau-c=.19, p=.000 for the Applied group; and Kendall's tau-c=.10, p=.003 for the CS group). Persistence was also measured through a question that asked how hard it is for the respondent to stop once they start work using computers. On this question no differences were found for either group. Similarly, no differences emerged for either group on the responses to a question that asked how likely a person would be to continue to think about a problem that was left unsolved in a computer class.

The variables listed above (along with a few others) related to attitudes about computer work were factor analyzed. Following varimax rotation, a three-factor solution emerged. Three of the questions related to ease of learning computer languages, self rating of programming skills, and self-assessment of the grades the respondent receives in programming classes loaded on the first factor, which we labeled “skill.” The second factor included the questions about comfort with computers, comfort with trying new things on the computer and self-confidence when working with computers. We called this scale “comfort.” The third factor included questions related to enjoyment and persistence; i.e., how much the respondent enjoyed talking with others about computers, how interested the respondent was in understanding how computers work, and how hard it is for the respondent to stop work once they start working on a computer. This scale also included questions related to thinking about an unsolved problem after computer class and the relative appeal the challenge of solving computer problems had to the respondent. Our label for this scale was “engagement.” Cronbach’s alpha measure of reliability was calculated to be .71 for the three-factor solution. The variables for each of the three factors were formed into additive scales and correlated with respondent gender for the CS and Applied groups.

The three new variables—skill, comfort, and engagement—significantly correlated with gender for both the CS and Applied groups. Though the Pearson’s r was higher for the Applied group than for the CS group in all cases (See Table 5), significant gender differences were found. In other words, men in both groups expressed feeling more skill and comfort and said they were also more persistent in dealing with computer issues.

**Patterns in the Groups**

We began this study by suggesting that the nature of the structure of the programs in information technology education that were more applied would be more woman-friendly and would therefore result in larger numbers of women in these programs who would persist to graduation. We noted that the problem of declining numbers of women in computer science programs might be addressed by examining the environment for women in the applied programs. This first part of our study of five institutions where computer science and other IT disciplines are taught surveyed the undergraduate and graduate students to determine if there were differences in the demographic characteristics, the uses of and attitudes toward computers; and the reasons for selecting a particular IT discipline for a major. Though the results for specific variables have been reported above, it is good to look at the overall picture of the men and women students in these two kinds of information technology educational programs.

The similarities between the women in these groups may be as interesting as the differences. We were somewhat surprised to find that women still don't feel as good about their abilities related to computers and computer programming as men do—whether that be in computer science or the applied units. It may be that the lack of confidence in their skills leads women to be less comfortable. The lack of confidence might stem from a lack of encouragement from teachers, friends and family since half of women in the Applied group and one-quarter of women in the CS group said nobody had encouraged them to go into an IT field. Even though men in both groups also said nobody encouraged them, men have other ways of building up confidence in their skills. Overall, men in both groups began using computers and learning to program them at younger ages and on their own. Mastering computer skills has its own way of reinforcing a perception of higher ability, and women either didn't have that opportunity or chose not to take it at the early age that men did. The result is that women end up in these college-level programs feeling a great deal of uncertainty about their skills. When other people have provided encouragement for these students, that has usually followed gender lines with men being more encouraged by other men and women by other women. The group of women in computer science was an exception in that they, more than women in the applied fields, said that their fathers were most important in making the decision to major in computer science. That was not so true of the women who had chosen an Applied IT field.

The biggest differences between men and women in the two groups are demographic; men and women in the Applied units tend to be older and men and women in CS tend to fall into traditional age groups for undergraduate and graduate students. This is not surprising given the number of older students in professional programs of all kinds in the university. Often in early- to mid-career, people decide to return to school to improve their chances of moving up a career ladder. And CS is not generally considered to be a strictly professional program. This means that reasons for entering the particular IT discipline may vary more widely between these groups than by gender within a group. However, the challenge of the subject matter and the flexible work schedule were reasons equally chosen by men and women in both groups. And men in both groups were more likely than women to say that being good with computers was a reason for entering the field. Consistent with other studies, women in the Applied area said that helping others was a reason for choosing an IT major. Perhaps the link between helping others and majoring in computer science needs to be made to attract more women to that major.

Though we believe that women in the Applied fields may see some advantages to studying IT outside a traditional computer science environment, in fact women in the applied majors suffer from some of the same problems related to their self esteem regarding computer efficacy. The discomfort and self-confidence issues for women in both groups played out in their assessment of the grades they get in programming classes when they compare themselves to their classmates. Women in both CS and Applied disciplines began working and playing on computers later than their male counterparts, Women in both groups tended to have been encouraged more frequently by other women than by men.

Most of the findings in this part of our study support earlier findings of several other studies that look at women's attitudes and performance related to technology. While this study hoped to find that women in applied information technology disciplines would have superior levels of self confidence and perceived degree of skill in the use of computing technology, that was not the case. We are concerned that the gender differences found in studies over the last 15-20 years persist today, even among populations of students who choose to major in computer science and in applied IT fields. We would support the conclusions of Clegg (2001) that call for policies to change the discourse related to women and computing. Her charge is that the disciplinary boundaries of computer science must be challenged so that the skills required to succeed in this field are not “culturally overlaid with the aura of masculinity” (p. 320). That happens, Clegg notes, because technology frequently drives the curriculum in schools rather than using technology when it “advances real educational capacities.” We agree with Clegg that the “questions concerning who has the power to shape the production and reproduction of gendered meanings in technology, and how transformations can be achieved, remain central in both theory and practice” (p. 321).

This study has only addressed part of this issue—how men and women undergraduate and graduate students in computer science and applied IT disciplines use computers, perceive their personal levels of skills and confidence, and choose to enter and remain in their fields of study. Future work in our larger study will try to determine whether policies that continue the gendering of IT work exist at the same levels in applied disciplines as they have historically existed in computer science.

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**Table 1**

**Year in School by Gender for CS and Applied Units**

**(N=1456)**

| | **Males** | **%** | **Females** | **%** |
|---|---|---|---|---|
| **Computer Science** | | | | |
| Undergraduates | 275 | 57.1%* | 64 | 56.1% |
| Master's Students | 63 | 13.1% | 13 | 11.4% |
| PhD Students | 144 | 29.9% | 37 | 32.5% |
| **Applied** | | | | |
| Undergraduates | 141 | 35.2%* | 56 | 12.2% |
| Master's Students | 206 | 51.4% | 357 | 77.8% |
| PhD Students | 54 | 13.5% | 46 | 10.0% |

*Percent within gender in Computer Science  or Applied
119 Computer science students (18.3% of total) and 193 Applied students (16.6% of total) did not identify their year in school in any of these categories.

**Table 2**

**Age by Gender for CS and Applied Units**

**(N=1496)**

| | **Males** | **%** | **Females** | **%** |
|---|---|---|---|---|
| **Computer Science** | | | | |
| 18-24 | 329 | 65.3* | 70 | 62.0 |
| 25-34 | 160 | 31.7 | 39 | 34.5 |
| 35-44 | 14 | 2.8 | 1 | .9 |
| 45-54 | 1 | .2 | 3 | 2.7 |
| 55-65 | 0 | 0.0 | 0 | 0.0 |
| **Applied** | | | | |
| 18-24 | 156 | 38.1 | 95 | 20.2% |
| 25-34 | 166 | 40.6 | 220 | 46.8 |
| 35-44 | 62 | 15.2 | 82 | 17.4 |
| 45-54 | 18 | 4.4 | 61 | 13.0 |
| 55-65 | 7 | 1.7 | 12 | 2.6 |

*****Percent within gender in Computer Science or Applied.
252 students did not identify their age. A few other responses could not be interpreted

**Table 3**

**When and Where Respondent Learned to Program a Computer**
**By Gender for CS and Applied Units**

| | (N=1250) Males | %* | Females | % |
|---|---|---|---|---|
| **Computer Science (N=602)** | | | | |
| On their own as a child | 108 | 22.1 | 6 | 5.3 |
| On their own as a teenager | 135 | 27.6 | 11 | 9.7 |
| Classes in summer or camp | 35 | 7.2 | 8 | 7.1 |
| Classes in middle/high school | 116 | 23.7 | 47 | 41.6 |
| Classes in university | 95 | 19.4 | 41 | 36.3 |
| **Applied (N=648)** | | | | |
| On their own as a child | 29 | 8.5 | 14 | 4.6 |
| On their own as a teenager | 78 | 22.7 | 18 | 5.9 |
| Classes in summer or camp | 13 | 3.8 | 16 | 5.2 |
| Classes in middle/high school | 78 | 22.7 | 70 | 23.0 |
| Classes in university | 145 | 42.3 | 187 | 61.3 |

Cramer's V=.28; p=.000 (for differences between men and women in CS)
Cramer's V=.29; p=.000 (for differences between men and women in Applied)

*Percent within gender in Computer Science or Applied

**Table 4**

**Gender of Person Identified as Individual Who Most Encouraged Respondent to Study Information Technology by Gender of Respondent for CS and Applied Units**

**(N=671*)**

| | Male | %** | Female | % |
|---|---|---|---|---|
| **Computer Science** | | | | |
| Person identified was Male | 169 | 75.4 | 41 | 56.2 |
| Person identified was Female | 48 | 21.4 | 26 | 35.6 |
| Person identified was spouse | 7 | 3.1 | 6 | 8.2 |
| **Applied** | | | | |
| Person identified was Male | 117 | 69.2 | 74 | 36.1 |
| Person identified was Female | 39 | 23.1 | 92 | 44.9 |
| Person identified was spouse | 13 | 7.7 | 39 | 19.0 |

Cramer's V=.19; p=.05 (for differences between men and women in CS)
Cramer's V=.33; p=.05 (for differences between men and women in Applied)

*N is particularly low as the rest of the respondents either identified "nobody" or "other" as the answer.
**Percent within gender in Computer Science or Applied

**Table 5**

**Relationship Between Gender and Attitudes toward Computer Work**
**For CS and Applied Units**

| | Correlation | Significance |
|---|---|---|
| **Computer Science** | | |
| Skill* | r=.19 | p=.01 |
| Comfort** | r=.28 | p=.01 |
| Engagement*** | r=.13 | p=.01 |
| **Applied** | | |
| Skill | r=.29 | p=.01 |
| Comfort | r=.34 | p=.01 |
| Engagement | r=.21 | p=.01 |

*Composite of three variables measuring respondents' assessment of grades in programming classes, ease of learning computer languages and rating of personal skill in programming.

**Composite of three variables measuring respondents' assessment of comfort with computers, comfort in learning new things on computers, and self-confidence when using computers.

***Composite of five variables measuring respondents' interest in understanding how computers work, degree of difficulty leaving work on a computer once they have started, persistence in thinking about unsolved problems from computer class, degree of appeal for the challenge of solving computer problems, and enjoyment received from discussing computers with others.