Catching Up to the 51%: Promoting Female Student Engagement in Computing Education

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Abstract

Between 1966 and 2006, the number of women who earned a computer science degree fluctuated, rising from 14.6% (1966) to 34% (1986) but thereafter falling to 20.5% (2006).[1] In contrast to this unpredictability, the demand for computing and information technology professionals has been steady, projected to grow about 20% in the next ten years. However, United States Census data show that, although women make up nearly half of the workforce, they hold only one quarter of all technology and computing jobs and have earned only 18% of the degrees awarded in computer and information science.[2]

To help better understand and respond to the current low percentage of female students in the major, we describe an initiative of the College's Computer Systems Technology (CST) Department. The CST department offers two degrees: an Associate in Applied Science (A.A.S.) in Computer Information Systems and a Bachelor of Technology (B.Tech) in Computer Systems. While the total enrollment of both degree programs has been steadily increasing over the past six years, the increase has largely been realized for male students while the percentage of female students has declined. Complementing ongoing studies of this phenomenon, our focus has been on the female student body of the department. A focus group of first-year and senior female students was formed and regularly gathered each semester to provide opportunities for female students and faculty members to share concerns, ideas, and experiences. Two surveys, one of all female students and another of all male students, were designed in consultation with the College's Assessment and Institutional Research Office to help understand the motivation of female students, their personal professional goals, learning experiences, as well as the challenges they face. Analyses of the survey outcomes guided strategies to a create female-friendly classroom environment as well as an awareness among all faculty members and students of the gender gap, leading to the determination to continue the efforts to inspire female students, supporting them throughout their studies and guiding them to be better prepared for what they choose after graduation, whether it be higher education or a career.

1. Introduction

New York City College of Technology is the designated senior college of technology within the City University of New York (CUNY) system. Located in downtown Brooklyn to provide quality education for the highly populated New York City metropolitan area, our college enrolls over 17,000 students, offers 66 degrees and certificate programs in the technologies of art and design, business, computer systems, engineering and technology teacher education, and the liberal arts and sciences. According to labor statistics projections from the New York State Department of Labor, the network systems and data communications analyst is the fastest-growing occupation, projected to grow 48% from 2008 to 2018.[3] The demand for computer software engineers is projected to grow 19.8% from 2008 to 2018, yet women, making up nearly

half of the workforce, held only one-quarter of all technology and computing jobs. In 2012, women earned more than half—57 percent (53 percent in New York)—of all bachelor's degrees, but only 18 percent of the degrees awarded in computer and information science, down from 37 percent in 1985.[3,4] Without immediate and numerous layered interventions, the lack of participation of women in computing is likely to increase.

The total enrollment of the college is 17,374 as of Fall 2014 including 55.9% of male and 44.1% of female students. The Computer Systems Technology (CST) department of the college offers two degrees: an Associate in Applied Science (A.A.S.) in Computer Information Systems and a Bachelor of Technology (B. Tech) in Computer Systems. The A.A.S. program prepares students for entry-level careers in computer programming, database programming, web programming, and systems/network administration and support. The B. Tech program allows students to specialize further in software development, computer networking and security, database management, and IT management.

The growing demand for IT workers in all aspects of computer systems has serious implications for our college and its student body. Located in one of the most highly developed and rapidly changing labor markets in the world, our college plays a very important role in preparing the new workforce. The total enrollment of both degree programs in the CST department has been steadily increasing over the past six years. From Fall 2008 to Fall 2014, the CST department had a total increase from 938to 1,637 students. However, the increase has largely been realized for male students. Overall, the percentage of female students decreased from 18.4% (*n*=173) to 14.6% (*n*=240). Such a decrease is not the result of entrance proficiencies, since, of the 52 female students entering CST in fall 2014, 29 (55.7%) had passed math, 46 (88%) had passed reading, 43 (82.6%) passed writing. Out of 380 male students, 215 (56%) passed math, 327 (86%) passed reading, 304 (80%) passed writing.

The CST department initiated a study of this phenomenon to understand and respond to the current low percentage of female students in the major and to seek effective support of female students advancing to their success.

2. Survey of Student Experiences

2.1 Assessment Goals and Challenges

Two surveys, one of all female students and another of all male students, were designed in consultation with the College's Assessment and Institutional Research (AIR) Office to help understand the motivation of female students, their personal professional goals, learning experiences, as well as the challenges they face.

With 217 responses from male students and 48 responses from female students, 42.6% of male and 27.10% of female students reported being the first in their family to attend college. Pertaining to why they chose computers as a field of study, 92.6% males and 91.7% females responded that they like technology, 23.1% males and 25% females like mathematics; 18.8%

female and 18.1% male were encouraged by family and friends and 55.1% sought more job opportunities.

When asked which concentrations they would choose from four areas of degree program, 12.8% female and 8.8% male chose Database; 29.8% female and 26.4% male chose Software Development; 47.7% male and 46.8% female chose Networking and Security; and 17.1% male and 10.6% female chose IT Operation (see Figure 1).

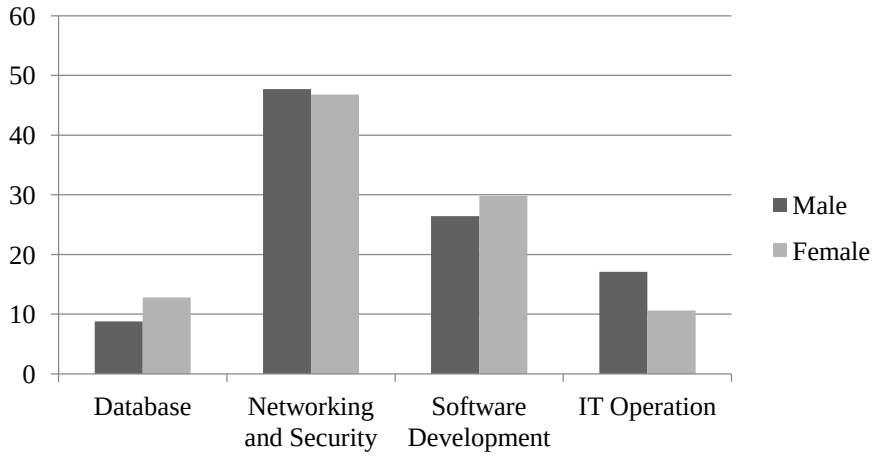

Figure 1. Specific interests of male and female students in the CST major.

When asked about the major challenges they faced during study, 28.9% of female students and 10.4% of male students felt challenged working in a team with male students whereas 13.2% of female student and 7.7% male students expressed encountering challenges with female students in team. In terms of course work, 39.5% of female students and 64.3% of male students found it challenging (see Figure 2).

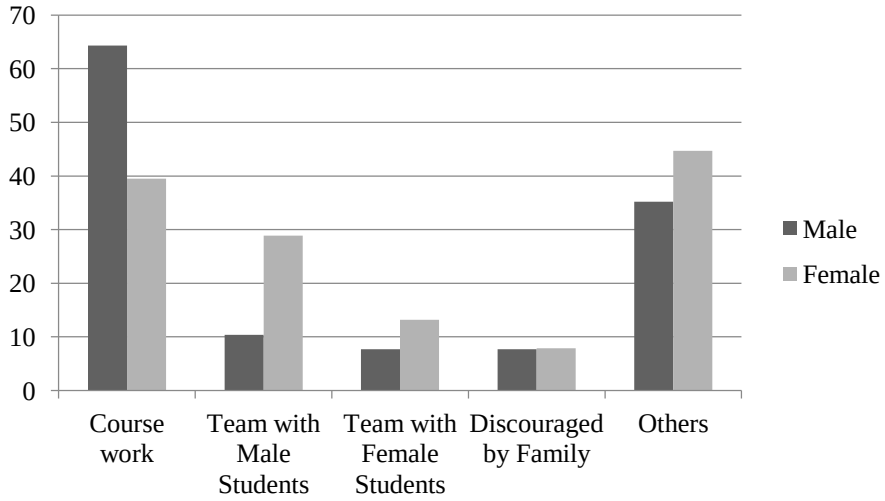

Figure 2. CST challenges faced by male and female students.

No male students explained their choice of "others" major challenges. However, some female students have 14% answered "No major challenges." One female student explained, "Freshman year sometimes I felt out of place when I was the only girl in class among guys but over the years I've worked past this." Another student noted, "Professors speeding along coursework because majority of the students which [sic] are dominantly males who already work in this field, already know this. Not giving enough time or breaking it down clear enough for you to actually learn what is being taught. It's just being shown." Yet another female student pointed to "Time management since I am a housewife" as a major challenge.

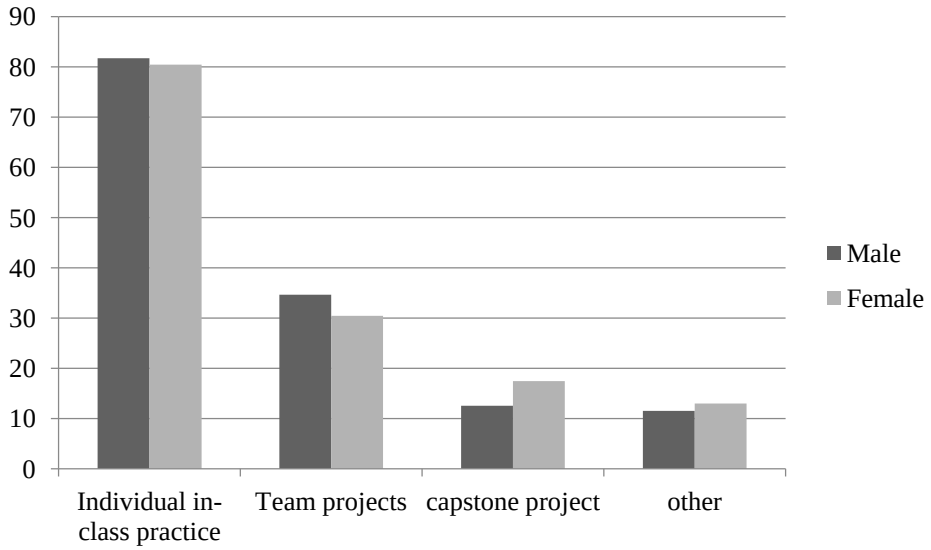

Figure 3. Number of male and female students who select effective learning method

When asked which method of learning they find effective, about 80% of both male and female students prefer individual in-class practice. One student noted "I learn better practically," and another pointed out that "effective tutoring, one-on-one or even group sessions at reasonable times during the week." Slightly more male than female students (34.6% versus 0.4%) prefer the team projects; slightly more female than male students think the capstone project is effective (see Figure 3).

When asked if they would continue pursue graduate studies, 73% of males and 79.1% of females answered that they would pursue graduate studies.

2.2 CST Female Student Focus Group

Complementing ongoing studies of this phenomenon, our focus has been on the female student body of the department. A focus group of first-year and senior female students was formed and regularly gathered each semester to provide opportunities for female students and faculty members to share concerns, ideas, and experiences. During the focus group session, some first- and second-year female students expressed an intimidated feeling sitting in a classroom as the lone female student. However, some senior students noted that they felt proud and encouraged to do well as minorities in the classroom; they "studied more" "by working it out on [their] own," and, they "found out [they] have a lot more in common with [male classmates] than [they]

thought." We also asked these female students what they thought would encourage other female students to choose computer fields. Many expressed that a role model of a successful female in the field would be very inspiring.

Our observations from the above-mentioned surveys, focus groups, and classroom discussions revealed the following concerns:

- The first-year experience is a challenge for female students. Not only do they need to familiarize themselves with the college, they are often the only one or two females in a class of 24 students.
- Although only 39.5 % female versus 64.3% male students find course work to be a challenge, about one-third of female students feel more challenge working in a team with male students.
- Some instructors do not pay attention to the gender gap in the class as common practice is to cater the lecture to the majority of the class, in this case, male students.

The CST department is determined to continue efforts to inspire female students, supporting them throughout their study of Computer Systems and guiding them to be better prepared for what they choose after graduation, whether this is graduate studies or a career.

3. Collegial and Professional Responses

Although many young women graduate from high school well prepared to pursue a science or engineering major, relatively few women pursue majors in science, technology, engineering, or mathematics, and, when they do, many capable women leave these majors before graduation. The American Association of University Women (AAUW) 2010 research report "Why So Few? Women in Science, Technology, Engineering, and Mathematics" presented in-depth yet accessible descriptions of eight key research findings that point to environmental and social barriers—including stereotypes, gender bias and the climate of science and engineering departments in colleges and universities—that continue to block women's participation and progress in science, technology, engineering, and math (STEM). Research finds that small improvements in the culture of a department can have a positive effect on the recruitment and retention of female students. The report made several recommendations, such as creating college environments that support women in science and engineering and raising awareness about bias against women in STEM fields.[1]

Researchers at the University of Washington found that the environment and bias against women—both implicit and explicit—still exists in science and engineering that might have contributed to why females don't like to choose the computer field.[5] If professors are aware that gender bias is a reality in computer technology fields, they can work to interrupt the unconscious thought processes that lead to bias. If women in particular in computer technology are aware that gender bias exists, it may allow them to fortify themselves, as it may be helpful to know that they are not alone.[6]

4. Interventions

In light of the above results of our survey, the CST department has initiated several support activities:

4.1 College Open House and New Student Orientation

To present a sense of shared experience among female students, the CST department prepared a short presentation of females in computing in addition to other materials used during the College Open House and New Student Orientation. The presentation highlighted a female computer scientist who made important successful contributions to computing technology development. The brief presentation demonstrated important contributions of female scientists and professionals at every stage of development of computing technology. The presentation was given to all female and male students with the intention of raising awareness.

Forty students (8 female) attended the departmental information session during the College Open House event on November 9, 2014. Four female students signed up to participate in a focus group. Twenty-four students (3 female) attended the two departmental new student orientation sessions on January 21 and 23, 2015. Two female students signed up to participate in the focus group.

4.2 Special Registration Advisement Sessions

Advisement helps students register for the proper courses by following their degree requirements; this is both important and challenging, as the CST degree program requirements are constantly under modification to reflect new technologies. Students entering the College at different times may follow different sets of requirements. Although the CST department, with its 17 full-time faculty members (4 female), provides advisement service to 1,600 students during the advisement period, many students find answers to their questions through their social groups in addition to meeting with the faculty advisors. Since female students might not have a large social network to turn to, the department reached out to all female students and provided two special advisement sessions during the registration period. Twelve students attended, and eight completed the survey. When asked if the session helped them understand the degree requirement, two "strongly agreed" and six "agreed" with this statement. Three out of the eight were not clear about the use of the online audit system before the session, but all understood the use of online audit system after the session. Since the session is designed to explain detailed degree requirements, through addressing the use of online audit tools, some students still need follow-up meetings with their advisor to resolve their specific issues.

4.3 Special Study Groups

The CST department received a Perkins grant from the New York State Department of Education in two consecutive academic years, 2013-2014 and 2014-2015. The grant supports a tutoring and mentoring program for first-year students in the CST department. The tutors and mentors are selected from senior students who were interviewed by the faculty coordinator to ensure that the tutors are "experts" in their areas (Java, Database, Networking, Programming, etc.). Tutors also

work with students over two semesters although they are not assigned specific mentees. They hold office hours in an open lab, where the students would approach them for technical questions regarding their courses. Mentors provide guidance for first-year students on their new journey in their first time at a four-year institution. Each mentor is assigned to a group of mentees, who would meet with them on a regular basis and provide them guidance on the courses to take and information related to the major. To help female students, special sessions were organized in the week before the final exams in addition to the regular tutoring schedule. The session included a 10-minute presentation about how to handle the stress in the final period and an hour of group study with tutors. Four students attended and all found the session helpful.

4.4 First-Year Experience Focus Group

The New Student Orientation is organized in a week before classes start each semester. During the orientation, students are informed about the departmental female student support activities. Female students are also invited to participate in the focus group. Throughout the academic year, the group will meet regularly, each time focusing on specific topics such as working in groups. The CST student computer club is very active group that organizes various activities to inspire and motivate learning, as well as to connect with alumni.

4.5 Awareness of Gender Gaps in the Classroom

The CST department organizes a semi-annual self-study of pedagogy. Each semester, a list of questions is collected from faculty members and organized into several different discussion topics, of which one will be focused on for discussion. How to teach a class with one or two female students will be our next discussion topic, since instructors normally teach at a pace suitable for the majority of the class. For some female students, this means they can be left behind.

CST instructors, including 74 part-time faculty members (12 female), will also give constant information to female students as announcements in class when there are upcoming activities (i.e., tutoring sessions, focus group meeting reminders, upcoming computer club events, etc.). This is done because the classroom is the best setting to ensure the attention of female students and to address an immediate need that they may have such as study groups for midterms and finals.

5. Conclusions

The literature on the drop in women in computer science over time does not present specific reasons for why this decrease happened. As a result, the analysis of our survey outcomes guided strategies to create a female-friendly classroom environment as well as an awareness among all faculty members and students of the gender gap, so as to lead to the determination to continue the efforts to inspire female students, supporting them throughout their undergraduate studies and guiding them to be better prepared after graduation, for graduate studies or a career.

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Acknowledgements

We recognize Perkins Major Effort Component project, which is supported by the New York State Education Department (NYSED) Grant Number 51980-05-24.