by Tracy Camp
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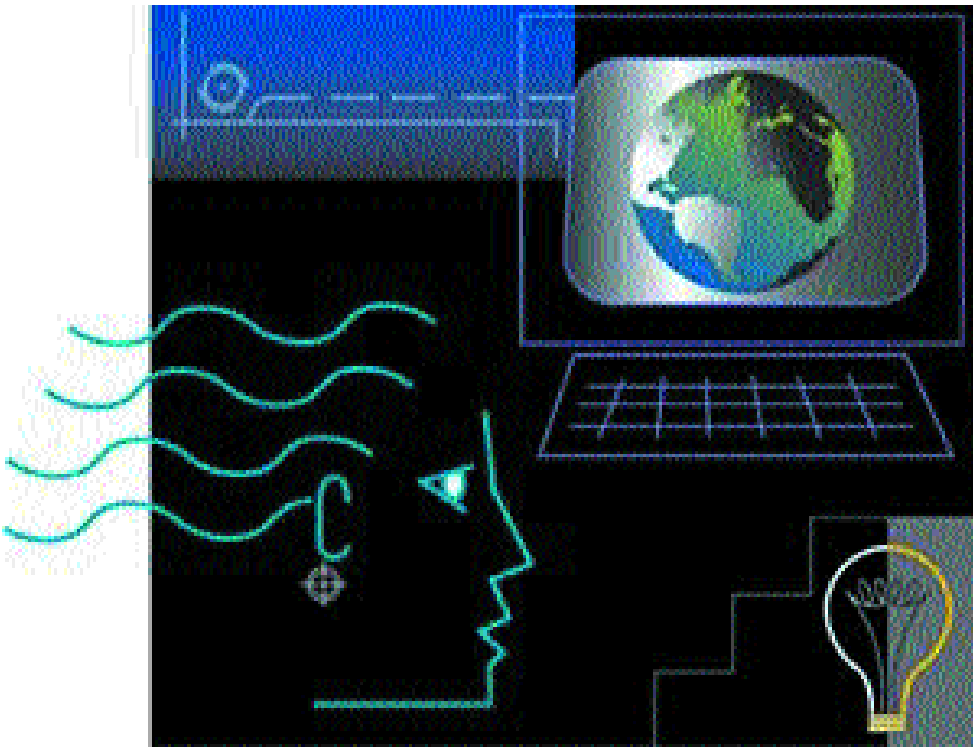
Women in Computer Sciences: Reversing the Trend



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The number of women entering the sciences and earning degrees is increasing in all fields but one: computer science. The reasons are rooted in the subtleties of gender culture, but the solutions are clearer. Here Tracy Camp provides some proactive measures and helpful resources for reversing the trend.

To create better computing technology, computing development teams need to have different perspectives, different points of view, and different approaches to problem solving. Men and women represent these different perspectives: While men usually focus on the computer and its technology, women most often focus on what the computer can do for society. Bringing these divergent personalities and abilities to the table creates better products, a fact that industry now realizes.

Fortunately, women are increasingly attracted to the sciences and are earning bachelor's degrees at an increasingly high rate. In fact, the proportion of bachelor's degrees awarded to women in all disciplines has increased almost every year for decades, to a high of 56.1 percent in 1997-98. Although these numbers are encouraging in nearly all fields, including almost all science and engineering fields, a reverse trend in computer sciences is alarming: Even though 37.1 percent of computer science degrees were awarded to female students in 1984, only 26.7 percent of those degrees were awarded to women in 1998, a decrease of 28 percent (see table). A study by Hornig shows that same-sex role models provide strong positive effects; thus, it is incumbent upon universities to attract, retain, and encourage female students and faculty in computer sciences. What can faculty members and universities do to help reverse this declining trend in computer science?

The Role of Academia

The most important move a university can make is to hire female faculty role models in computing departments. However, this task may prove difficult with only 14-16 percent of the doctoral degrees awarded in computer science going to women. To help increase the pool of female faculty members in computing, both universities (through scholarships) and faculty (though advising) should encourage female students to attend graduate school in computer science. Both

the American Association of University Women (www.aauw.org/3000/fdnfelgra.html) and Lucent Graduate Research Program for Women (www.belllabs.com/fellowships/GRPW/) offer scholarships for women considering graduate school in computer science. Other information on financial aid for students considering graduate school in computer science is also available at www.cs.washington.edu/ homes/rap/aid.html.

Several other initiatives can bring more women to the forefront of computer sciences:

- Locate a woman when a speaker on a particular computing topic is desired. A female keynote, for example, illustrates that successful women do exist in computing. A database from CRA-W (see box) is available to help identify qualified female computer scientists as speakers. The database provides technical information about women who have earned doctoral degrees in computer science.
- Encourage female computing students to participate in online female computing communities such as Systers (www.systers.org). Systers is an e-mail or Web-based forum for women who are involved with the technical end of computing. Currently, the Systers community consists of more than 2,500 women computer scientists in 38 countries. For more focused discussions, there is a Systers-students forum for female students in computing and a Systers-academia forum for female faculty and doctoral candidates in computing. To join Systers-students, e-mail systers-students-request@cs.umass.edu; to join Systers-academia, e-mail leveson@mit.edu.
- Provide cost-sharing for attendance and encourage participation in the Grace Hopper Celebration of Women in Computing (www.gracehopper.org). This gathering is a technical conference celebrating the research and career achievements of women involved in computing. Travel grants are awarded to students (and new faculty members) to attend this conference. Priority for awards is given to the applicants who are presenters at the conference and those who have partial cost-sharing from their institutions. Highest priority is given to applicants who are presenters with partial cost-sharing.
- Organize an ACM-W Student Chapter in the institution's computing department. An ACM-W Student Chapter is specifically devoted to activities focusing on recruiting and retaining women in the computing fields. One sample activity for an ACM-W Student Chapter is a mentoring program, similar to the Big Sister/Little Sister program (www.cs.cmu.edu/~women/) at Carnegie Mellon University. This CMU program connects graduate students and upper-division students with lower division students for mentoring purposes.

Since 1995, faculty and university administrators have implemented numerous programs like Big Sister/Little Sister that change the curriculum, pedagogy, and culture in order to expand the diversity of the student body. Due, in part, to these efforts, CMU has witnessed a dramatic rise in the percentage of entering undergraduate women in computer science from 8 percent in 1995 to 42 percent in 1999.

Faculty as Mentors

A major challenge for women in computing is a lack of confidence with computers. For more than three decades, UCLA's Higher Education Research Institute has done a survey to, among other goals, gauge the confidence of entering first-year students at more than 1,700 colleges and universities. The survey results have repeatedly shown that male confidence with computers is much higher than that of females. Furthermore, the 2000 survey found that the confidence gap is "the largest in the history of the survey." Peter Lee,associate dean of CMU's undergraduates in computer science, notes that "women tend to do less well in the early programming class." One conclusion of a study by Kiesler, et. al confirms this statement: Students who have played computer games (typically male students) are more likely to do well in their first college-level computing course. Faculty members who teach introductory

Percentage of Bachelor Degrees Awarded in Science and Engineering to Women: 1980-81 through 1997-98

Data obtained from the National Center for Education Statistics at the U.S. Department of Education.

CS: computer science

Bio/Life: biological/life sciences

Eng: engineering

Math: mathematics

Phy: physical sciences

Academic Year	CS	Bio/ Life	Eng	Math	Phy	All Deg.
1980-81	32.5	44.1	10.3	42.1	24.6	49.8
1981-82	34.8	45.4	11.4	42.8	25.7	50.3
1982-83	36.3	46.0	12.3	43.6	27.3	50.6
1983-84	37.1	46.8	12.8	43.9	27.6	50.5
1984-85	36.8	47.8	13.1	46.2	28.0	50.7
1985-86	35.7	48.1	13.1	46.3	27.5	50.8
1986-87	34.6	48.4	13.7	46.4	28.4	51.5
1987-88	32.4	50.3	13.7	46.3	30.4	52.0
1988-89	30.8	50.2	13.6	45.8	29.7	52.5
1989-90	29.9	50.8	13.8	45.7	31.3	53.2
1990-91	29.3	50.9	13.9	46.6	31.6	54.0
1991-92	28.7	51.6	14.0	46.6	32.6	54.2
1992-93	28.1	51.4	14.4	47.2	32.6	54.3
1993-94	28.4	51.3	14.9	46.3	33.6	54.5
1994-95	28.1	52.3	15.6	46.8	34.8	54.7
1995-96	27.5	52.7	16.1	45.7	36.0	55.2
1996-97	27.2	53.9	16.6	46.1	37.4	55.6
1997-98	26.7	55.1	16.8	46.5	38.4	56.1

college computing courses need to give extra encouragement to their female students in these courses. Otherwise, the combination of lower confidence and lower grades (compared to their male colleagues) leads to a retention problem of females in computing departments.

Thus, when teaching an introductory college computing course, faculty need to be aware of students' past experiences with computers. In other words, introductory computing courses should be taught to the least experienced students in the class. Unless a course is designed for those less experienced students in the class, female students will be left behind on the very first day.

In meeting these challenges, women who do earn computing degrees are usually the students who earn high grades, while many males with average grades earn degrees. Very few females with average grades earn computing degrees. It is easier for an exceptional female student to may think, "Yes, I belong in this male dominated field." On the other hand, when her performance is average, her feeling that she does not belong in computing will be reinforced. Consequently, faculty members should give extra encouragement to their female students who earn average grades in computing courses.

Faculty can also provide female students with opportunities for successful professional experiences in computing through the Collaborative Research Experience for Women (CREW) and the Distributed Mentor Project (DMP) from CRA-W. CREW provides funding to support collaborative research experiences for groups of two to three undergraduate women during the academic year. DMP matches an undergraduate woman with a female mentor for a summer of research at the mentor's institution. Funding is provided for the student's travel to the mentor's institution, as well as a student stipend of $550 per week for the research performed. CRA-W hopes that both CREW and DMP will increase the number of women that attend graduate school in computer science.

Further discouraging women in computing is an incorrect stereotype that computing is a solitary and antisocial activity. To help counteract this stereotype, computer science faculty can adopt cooperative learning techniques in their classroom, assign group problem-solving activities, and invite local industry employees (preferably women) to the campus to discuss a typical day at their job.

Another factor emerged in a study by Camp that statistically proved that women are less likely to obtain a degree from a computing department that is within an engineering college than from one in a non-engineering college, such as the College of Arts and Sciences. Specifically, if a computing department moves from a non-engineering college to an engineering college, the department can expect an 18 to 26 percent decrease in bachelor's and master's degrees awarded to women and a 7 to 8 percent decrease in doctoral degrees awarded to women in their department.

ACM-W: Association for Computing Machinery's Committee on Women in Computing (www.acm-w.org)

CRA-W: Computer Research Association's Committee on the Status of Women in Computing Research (www.cra. org/Activities/craw/)

ACM-W and CRA-W are both dedicated to increasing the number of women participating in computer science research and education. To meet this goal, both organizations have active projects on topics of importance to women in computing. Overall, ACM-W focuses on K-12 issues, CRA-W focuses on graduate student issues, and the two organizations work together on undergraduate student issues.

Gaining Ground

Why should anyone care about the declining percentages of women earning computing degrees? Clearly, the larger number of women earning degrees in the early 1980's proves that women are interested in computing. Women are choosing non-computing majors not due to lack of interest, but due to other factors often beyond their control. Obviously, in our university communities, we need to ensure we are working from an inclusive model, not an exclusive one. The future of society demands that we do.

The Institute of Women in Technology (www.iwt.org) is illustrating the impact of women developing technology through their Virtual Development Centers (VDC). A highly collaborative environment is created in a VDC, where women are inspired to demand useful technology for their needs. While the VDC program is still new, participants are discovering that technology developed by and for women is vastly different from the technology developed by and for men. Thus, to ensure that technology is useful for everyone, not just the 49 percent male population, it is imperative that we have a diverse mixture of people working to design, develop, and implement our computer systems.

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