How Does Engaging Curriculum Attract Students to Computing?

The content of computing curriculum, especially introductory courses, is believed to contribute to the under-representation of women in information technology (IT). Research suggests that women are more interested in using computing as a tool for accomplishing a goal than they are in the workings of the machine. For example, certain IT instructional programs enroll higher proportions of women than do others. Data from a five-university study showed that women’s average representation was lower in computer science than it was in management information systems, informatics, instructional systems technology, and information science/studies, though it was still below parity in these fields. Similarly, reports suggest that women’s participation in computing might increase when media applications are used for teaching fundamental concepts (e.g., see the Media Computation approach on the reverse of this page).

In addition to more relevant and meaningful curricula, the greater participation of women in these IT disciplines and curricular programs may be due to the social climate. More women are present, so it is easier to develop an identity as a technical woman in a technical social context. These research findings show great promise for increasing the appeal of computing to women.

Establishing alternate pathways into IT study is another way that female under-representation has been addressed. According to Margolis and Fisher in their 2002 book, Unlocking the Clubhouse, introductory courses at Carnegie Mellon University that were tailored to different experience levels resulted in higher satisfaction for both more and less experienced students and for both male and female students.

Special accommodations for women? No. Most educational research shows that interventions that are better for women are also better for men. For example, collaborative learning environments lead to improved learning outcomes for all students, not just women. And bridge courses make it possible for a much larger and more diverse pool of students to “try out” computing, beyond those who elected to take computer science in high school.

As the Joint Task Force for “Computing Curricula 2005” points out, computing is no longer a monolithic area of study. The different curricula of the “family of computing-related disciplines” (p. 1) should be studied for their potential to attract high-quality male and female students and produce highly qualified computing professionals.
The Media Computation approach to teaching introductory computing developed at Georgia Tech is being effectively implemented now at over a dozen institutions. The two-course sequence aims to make computing more attractive to a wider range of students, especially women, by focusing on computing in an interesting context that is relevant to students’ everyday lives. The purpose in developing the course was to solve problems that, in studies, were shown to drive away students from computer science, by:

- making course content relevant to non-CS majors
- emphasizing creative opportunities in computing
- fostering a positive social climate in the class

Like traditional introductory courses, the two-course sequence introduces computing concepts and data structures in a context of creating and manipulating media. For example, in Introduction to Media Computation, students learn about loops by creating picture negatives or reversing sounds, learn about conditionals by implementing red-eye removal and edge detection, and learn about string processing by writing programs that pull information out of web pages. In Representing Structure and Behavior, students experience linked lists, trees, stacks, and queues by creating animations through continuous and discrete event simulations.

Multi-year evaluation results of the Media Computation approach have been encouraging:

- Retention has improved dramatically, from a 72% success rate (earning an A, B, or C) to an 85-90% success rate in both courses. The introductory course is about 300 students per semester and has a 51% female population. The second course was 75% female in its first offering.
- Women in the media computation course are more likely to report that the course is relevant to their lives than are women in the traditional first course.
- Women report finding the course to be creative, with a rich social context supported by an online environment for sharing media.
- The course changes students’ perceptions of computing and computer scientists.

Comparable effects on retention and attitudes toward computer science also were shown at Gainesville College (a two-year public college in northern Georgia).

A challenge to securing faculty adoption of the sequence is that its goal is not to produce software developers. Even in courses explicitly for non-CS majors, many computing faculty want to emphasize standards for good programming rather than more domain-specific computing skills or more general concepts of computer science. However, students report that many of their learning experiences are powerful for helping them think about what computing can provide in their domains.

A key element in the success of the first course is making assignments open-ended and providing an online web space for students to share their media. Most adopting schools have used assignments like the collage assignment, which allows students to use their own media in their own designs. Adopters who have then provided students with a place to share their collages (as well as other images, sounds, and movies) have had similar outcomes to those of Georgia Tech. Adopters who use open-ended assignments but don’t provide a place to share the media have not always seen the same improvements in retention.

RESOURCES

Research papers, curricular materials, and implementation suggestions for the Media Computation approach can be found at http://coweb.cc.gatech.edu/mediaComp-plan.


NCWIT offers practices for increasing and benefiting from gender diversity in IT at the K-12, undergraduate, graduate, and career levels. This case study describes a research-inspired practice that may need further evaluation. Try it, and let us know your results.
Curriculum is one of the factors that contributes to the spectacularly successful pre- and early-computing major redesign carried out at Harvey Mudd College (HMC). Since Fall 2006, with faculty support, their introductory course separates students according to prior computing experience, takes a breadth first approach, and includes a faculty-led lab. Together with early student engagement in research, participation in the Grace Hopper Celebration of Women in Computing, and the presence of a prominent high-level champion for women in computing, these steps have held student performance steady while skyrocketing women’s representation from consistently less than 20% all the way to 50% of the incoming computer science majors. See Figure 1.

Almost all of the women responding to a survey question about influences on their desire to major in CS indicated that this first course influenced them. For example, students wrote:

- “It was surprisingly fun, and I learned I could do a lot with computers.”
- “I knew basically nothing about CS when I came to Mudd, so CS1 was really my first look at it. After [the introductory course], I really wanted to take [the next course], which eventually convinced me to major in CS.”
- “[The introductory course] was the first programming course I’d ever taken and it opened my eyes to the fun and challenges that CS could provide for me. Future classes served to reinforce this first impression and convince me it was something I enjoy and do well.”

KEY ELEMENTS IN THE COURSE’S SUCCESS

Broad but Tracked Enrollment

All incoming HMC students, typically around 200, enroll in the first computing course, so everyone, regardless of intended major, gets exposed to computing. Experienced and inexperienced students enroll in different sections, which minimizes mistaking familiarity for aptitude and the negative impact that mix-up has on inexperienced students’ confidence.

Faculty-led Labs that Assist Students

Faculty lead weekly 2-hour labs. The labs give students the option of getting structured help from a faculty member. The labs also give attending students full credit for one of the three or four assigned weekly homework problems.

Breadth-first Content that Capitalizes on Existing Interests

The new CS1 course immediately provides students with tools for writing engaging and useful programs and aligns assignments with students’ existing interests. At HMC, that interest is science or engineering, so the course begins with science and engineering task-specific functions. A summary of the course content is provided in Figure 2 (Dodds et al., 2008).

Support from and for Faculty

The department chair reports that computer science faculty believed that the “old” CS1 course reinforced negative stereotypes of computer science (i.e., “CS is all about programming,” “CS is about machines,” “CS is not creative”), saw the need for improvement, and encouraged a working group to design a new course. The demonstrated success of the new model and the existence of tested and complete course materials (e.g., assignments, lecture slides and notes, other resources) make it relatively easy to recruit additional faculty members to contribute to the teaching of this course.

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