Ten Keys to Involve More Women in Academic Computing

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This note is a brief distillation of ten ideas the authors have found, in their own experience and in discussions with dozens of other universities, to be pivotal in increasing the participation of women in computing programs. The goal has been to provide a list that can serve both as a starting point and as a set of reminders to practitioners engaged in that endeavour.

Introduction

In January of 2002, MIT Press published our book *Unlocking the Clubhouse: Women in Computing*. The book detailed our findings and experiences with regard to gender issues in the undergraduate computer science program at Carnegie Mellon University, one of the leading academic centers of computing in the United States.

From 1995 to 1999, we interviewed both men and women as they made their ways into and out of the program, and meanwhile worked on means of increasing the participation of women students. From the fall of 1995 to the fall of 2000, the percentage of women among entering students rose for 7 % to 42 %, and persistence toward graduation also improved. Since the publication of *Unlocking the Clubhouse*, we have had the opportunity to visit dozens of universities, mostly in the United States but also a number in other countries, to share our experiences and learn about local conditions. The details of what happened at Carnegie Mellon are reported in the book; this note synthesizes our Carnegie Mellon experiences with our subsequent learning from colleagues at many disparate universities, and attempts to distil them into a concise set of key reminders for those seeking to involve more women in their computing programs.

1. Understand Your System and Know Your Numbers

While lessons from other settings and other „diversity projects“ can be instructive, it is important to understand your local situation well enough to customize a general set of strategies. The critical question is how the strategies and results from successful initiatives in other places apply to your own institution. The management truism that „you can't improve what you don't measure“ applies here. Where is the bottleneck in your department? Is it in admissions? Is it in retention? What are the retention rates of women in computer science? What have the trends been? When are people being lost? How do the numbers of women students and faculty members in your department compare to other technical departments in your institution? What is the culture of your department? How do women experience the department?

Local information, especially in the form of hard numbers, is critical to community engagement. While information about the gender-gap from other places can be imported, especially when you have a „convinced audience“, there is nothing like shining a light in your dusty corners to make an institutional community take notice.

2. Build a Powerful Team

A significant commitment of time, energy and resources – not just blessing and encouragement – by organizational leaders seems to be essential for success. Gender investigations and interventions too often are led by „outsiders“, then marginalized and not taken seriously. At best, they often become one more report that will just sit on the shelf.

Nonetheless, the involvement of outsiders is important. Changing the dynamics of the gender-gap in computer science requires expertise from multiple disciplines (computer science, women's studies, psychology, education, history of science, anthropology, sociology, etc.). Each has a key to the puzzle that the others lack.

The end-game of building a team is the engagement of the community at large. Only through cultural change and buy-in does a transition become permanent, outlasting its original champions. Finding and facilitating „virtuous cycles“ – for example, involving more women increases faculty interest, which improves programs, which attracts more women – is an important principle.

3. Listen to Students

Listening to student (and faculty) experiences can identify trouble spots in a department. But to learn about those experiences, a process that allows you to hear more than the „party line" and more than what is „safe" to talk about is needed. Interviewees must be able to speak confidentially, and to talk about topics not commonly discussed in computer science culture.

This process calls for some expertise with data collection methods to avoid biasing your results. For example, open-ended questions can be critical to this process because they encourage interviewees to describe and shape their own accounts of their experiences (such as „Can you tell me the story of you and computers?" or „Can you tell me about your decision to major in computer science?") rather than choosing among preselected generic answers. On the other hand, be open to using multiple forms of data gathering techniques, including survey questionnaires. Different people listen to different types of data. The key considerations are that students' own perspectives are being heard and that the process you use does not bias what you hear.

It is also important to think longitudinally. It is simplistic to think of the gender-gap in computer science in terms of a static set of influences. Rather, we must consider a web of influences and a sequence of turning points, at each of which a different set of factors may be critical. These webs of influence are most apparent over time.

4. Focus on the Bottlenecks

In the 1990s, Carnegie Mellon's School of Computer Science was losing women in two main ways: at admission time, where all three of application, acceptance and matriculation rates were lower for women than for men; and in the early years of the curriculum, where negative experiences and a sense of „lack of fit" created disproportionate attrition among women. In other settings we have seen, introductory courses, processes for choosing one's major, and „weed-out" courses have posed bottlenecks. It is critical to monitor such bottlenecks over time, and to focus interventions there. Keep in mind that eliminating a bottleneck often will involve multiple dimensions of policy, process and culture. Some key heuristics for addressing institutional bottlenecks are to

- Use appropriate recruiting and selection practices;
- Provide multiple pathways for students with differing levels of experience;

- Mentor all students;
- Foster a high-quality and positive learning environment;
- Create and communicate a culture that supports and celebrates multiple approaches to the study of computer science.

5. Catalyze and Support Women's Community

A technical/professional group for women students, such as Carnegie Mellon's Women@SCS and Berkeley's WICSE, plays several important roles. Perhaps foremost, it provides an environment for women to experience being female computer scientists together with others, without feeling the need to „learn to speak boy" (as eloquently phrased by Anita Borg) in order to be in the field. In this vein, it provides a venue both for professional development experiences and for mutual support. The most successful instances of such groups seem to combine substantial student leadership with ongoing faculty support.

Beyond its direct impact on its membership, a women's group amplifies the visibility and voice of women in the larger community. At Carnegie Mellon, the women's group has developed representation on standing committees, has organized events for the entire community, and has developed a variety of recruiting and outreach activities – even assisting in the creation of women's groups at other institutions.

6. Broaden the Culture

Most computer science faculty think of Computer Science as a dynamic, multi-disciplinary field that combines aspects of mathematics, engineering and science and has application in nearly every field of human endeavour. However, many prospective students, including some of the most enthusiastic, inherit from secondary school and society a narrow notion of Computer Science as focused on computers and on coding. Addressing this ongoing legacy is a key challenge for the computing community.

Further, the introductory sequences of traditional curricula often reinforce narrow images of the field, by focusing primarily on equipping students with the programming tools they will use in later, more diverse courses. Carnegie Mellon's response to this issue has included the addition of an „immigration course" introducing new students to the breadth of the field. Other institutions have developed introductory courses that use integrative projects that focus on principles over programming, or

that link Computer Science to applications, to help to broaden students' vision.

Another critical cultural notion is the image of a successful Computer Science student. Again, for many entering students as well as for many faculties, one standard profile of interests and work habits may dominate the culture. It is difficult but important to sort through the ways in which different orientations and work styles serve the institution's goals, and to support multiple approaches that work well. For example, Carnegie Mellon's admissions processes have been adapted to give weight to measures of leadership and community engagement in addition to sheer technical virtuosity.

7. Reach Out to the Feeder Community

Teachers, counsellors and students in secondary schools often have a very narrow view of the nature of computing and computing professions. Even where computer science programs exist, they typically focus on technical details of programming rather than the broader theory and application of computing.

Find opportunities to reach out to secondary school educators and administrators in your recruiting area, providing them with a broader picture of computer science, outreach programs, mentoring, research opportunities, and a professional community for CS teachers. They will respond by doing a better job of recruiting students for their courses, and by sending their students to you. In particular, their awareness that you are interested in promoting the involvement of women will work in your favour.

8. Keep a Close Watch on the Student Experience

In most academic settings, especially in large institutions, key interactions with students are factored across multiple organizations: admissions, academics, student affairs, housing, career counselling, etc. Each of these areas presents opportunities to foster or weaken a student's affiliation with a discipline. It is invaluable to work cross-functionally: both to provide students with appropriate and positive experiences, and to prevent blind spots that can miss such opportunities, or worse, create bad experiences that drive students away.

For example, while Carnegie Mellon's reputation and recruiting power played a key role in its rapid increase in the involvement of women in computing, we believe that the university's culture of working across organizational boundaries was also an essential factor. At various times, we were able to work closely with admissions staff, other colleges, the student affairs office, and others to tailor programs to the needs of computing students, and to close up an assortment of „cracks" through which students might otherwise have slipped.

9. Adapt to Changing Times

Change is a constant, especially in a field like computing, with its rapid technological change and dynamic business cycle. Today, a new generation has grown up with the Internet and all it implies. A bit more than a decade ago we saw the first inklings of the Internet boom, and now we have been through boom, bust, and consolidation. At this writing, perhaps the key human resource challenge to the discipline of computing in the developed countries is the public perception that „all the computing jobs are going offshore" to the developing world.

Just as the external environment changes, communities change. For example, Lenore Blum and Carol Frieze have observed a shift in the Carnegie Mellon computer science student culture, in which both men and women are likely to take a broad and connected view of the field, and in which the traditional gender stereotypes of computing are largely defused. In light of internal and external changes, it is necessary to revisit your assumptions regularly in order to adapt to new sources of challenge and advantage.

10. Remember the First Law of Educational Diversity

For a student who is a member of a small minority, particularly one labouring under negative stereotypes, seemingly small and sometimes unintended slights often are magnified. Cumulatively, they chip away at a student's confidence. This, in turn, often leads to a loss of interest in the discipline.

The ubiquity of these effects is tantamount to the First Law of Educational Diversity: in a situation with in-groups and out-groups, „everything bad happens worse" for the members of the out-groups. Because of doubts about fit, comparisons with members of the in-groups, and the

feedback between confidence and interest, bumps in the road – poor teaching, lack of advising, weed-out experiences, etc. – disproportionately create disaffection and attrition among the out-groups. Note that a corollary of this observation is that many effective interventions in favour of diversity are good for all students.

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