EEES
Engineering Equity Extension Service

What Can I Do?
Making Engineering Classrooms More Effective for Women (and Men) Students

The teacher who can ask of students, "What do you need in order to learn?" or "how can I serve?" brings to educating a spirit of service that honors the students' will to learn. (bell hooks, 2003)[1]

I. Integrate applications into your teaching of fundamental concepts. However, check to see if the applications are familiar and of interest to your students.

Integrating applications into the teaching of fundamental concepts increased women's recruitment and retention at Carnegie Mellon in computer science and at Drexel in engineering (Margolis & Fisher, 2002; Fromm, 2003). However, it is important to make sure that the applications are familiar and of interest to students. As Georgia Tech Dean Sue Rosser explained:

> I see math classes where vectors are taught using sails and sailboats. This may work very well in [Maine]. I am originally from the Midwest, and I can tell you that there are a lot of students who have never seen a sailboat. They may never be able to understand the idea that you are talking about vectors and listen to the math. Because they are so panicked over the fact they know they are not familiar with the example, they think they can't understand what this person is going to be talking about. (Rosser, 2004)

Earlier work on test items confirms this. When the same concepts were being tested, students were more apt to get a test item correct if the context of the test item was familiar to them (Chipman, Marshall, & Scott, 1991; Lynn & Hyde, 1989).

II. Periodically stop talking and pause. Wait at least three seconds after asking a question before calling on someone to answer. (Count to yourself 1 Mississippi, 2 Mississippi… if you need to).

After asking a question, most instructors will wait a second or less before either getting or giving an answer. For over 30 years, research has shown that increasing "wait time" (e.g., waiting three or more seconds after asking a question) has a positive impact on student participation and response (i.e. Rowe, 1974; Tobin, 1980, Mansfield, 1996). Universities from Stanford to Chapel Hill have recommended that faculty increase their wait time to increase participation by all students, especially those who have historically participated less.

Computer science professors at the University of Colorado have gone a step further and use the Conversational Classroom, where instead of lecturing, they come to class and ask students if they have questions, thus or making students engage each other and the professor in intellectual conversation about the material. Not only do students learn the material better, but the course structure requires that they engage with the professor and their fellow students, two known factors in increasing the retention of women in computing (Barker & Cohoon, 2006).

III. Praise, but carefully. Praise students as individuals not as representatives of their sex or race. Praise only when it is deserved, and watch your language. What you see as a compliment can be seen as an insult by others.

[1] hooks, bell. (2003). *Teaching Community: A Pedagogy of Hope*. New York: Routledge. p. 92.

Production of this material was made possible by a grant from the National Science Foundation . Opinions expressed are those of the authors and not necessarily those of the funders.

Research done on students at a variety of age and ability levels has shown the value of praise (i.e. Merrett, 1996; Brophy, 1981). However to be effective, praise must be earned. As Carol Dweck (1999, p. 1) says, based on her research and others, "Giving students easy tasks and praising their success tells students that you think they're dumb." And that, as Nina Simone Dudnik (2006, p.107) points out, is counterproductive.

> And then there was the high school physics teacher who made a big show of encouraging the girls in our advanced placement class. If he really believed we were just as good as the boys, would he have made such grandiose gestures of praise?... One by one girls dropped out of that physics class. I couldn't help noticing that many of them stuck around for AP Chemistry where the teacher made no mention of anyone's gender in the lab.

One person's idea of praise may be taken by another as an insult:

> Sara (not her real name) was told by the interviewer that he had never before thought a woman could do this particular job but she had the technical skills to do the job. Sara found this negative and insulting and stopped the interview; another woman may have seen the incident as a positive one. (Campbell & Perlman, 2004, p. 12)

IV. Encourage student collaboration. If you teach programming, use pair programming assignments. If you use small groups, cluster women students in groups so the numbers of women and men in a group are approximately equal.

Since the 1970s, when Uri Treisman's use of student study groups dramatically increased the calculus success of under-represented students, having students work together is seen as a useful strategy to increase student success (Treisman, 1992). More recently, pair programming, where two students work together on programming assignments, has been found to be an effective way to increase achievement, retention, and confidence of both women and men students (McDowell, Werner, Bullock, & Fernald, 2003).

There are some cautions. When students are working in small groups, it is often the male students who acquire the leadership positions. Generally, males are more verbal than females and often they ignore female suggestions (Moskal, 2000; Webb, 1984). Assigning and/or rotating tasks within groups can help counter that. The gender composition of groups can also have an impact on participation. Women students have been found to be more engaged when they were in single sex groups or in groups with equal numbers of women and men than when they were in the majority (3:1) or in the minority (1:3). In the same settings, men's behavior didn't change (Adams, Brissenden, Lindell, Slater, & Wallace, 2002). The proportion of women on student engineering design teams had other effects as well. As the proportion of women increased, the quality of the product increased but overall team satisfaction decreased. The more satisfied teams produced lower quality products. The less satisfied teams produced higher quality products (Knecht & Carlon, 2002).

V. Check your classroom climate. Decide what you want your classroom to be like in terms of such areas as student/professor and student/student respect, student participation, and student comfort level. Write down your expectations and check periodically to see what the climate actually is.

How students are treated in the classroom can have a major impact on both their achievement and continuation. Since the 1980s, people have been concerned about the "chilly climate" for women in academia (Sandler, ND). Women and students of color "can be isolated from their peers because their status as a classroom minority makes them both more and less visible and vulnerable to stereotypic comments, thoughtless assumptions and casual jokes." (Marchesant & Adams, 1992, p. 12).

A body of research on the concept of stereotype threat ties into this. Stereotype threat "refers to the experience of being in a situation where one recognizes that a negative stereotype about one's group is applicable to oneself" as in the stereotype that women do not do well in advanced mathematics (Steele, 1998, p.6). Being subjected to this stereotype threat depressed the scores of women students on a difficult math test while being told this was not the case improved their performance (Spencer, Quinn, & Steele, 1999).

VI. Provide research experiences for undergraduates (REU).

As the National Science Foundation (NSF) explains:

> Research experience is considered to be one of the most effective avenues for attracting talented undergraduates to and retaining them in careers in science and engineering, including careers in teaching and education research…. REU opportunities are an excellent way to reach broadly into the student talent pool of our nation. NSF is particularly interested in increasing the numbers of women, under-represented minorities, and persons with disabilities in research. (National Science Foundation, 2005)

Controlled research has found participation in undergraduate research experiences increasing the retention of minority REU participants in engineering (May, 1997). In addition, two well-controlled evaluations found REU programs for minority students successfully recruited and enrolled students into graduate schools however a third found the REU participation did not change whether students of color or women expected to go on to graduate school (Seymour, Hunter, Laursen, & Deantoni, 2004).

VII. Work with others to provide undergraduates with more opportunities to transfer into engineering.

Research has found that the majority of practicing female computer professionals did not decide to enter computer science as a field of study until after beginning their junior year of college (Camp, 1997). Women may use the first two years of college to identify an appropriate career. However, many colleges require that science and engineering majors enter their degree programs at the start of their freshman year. This requirement prevents young women and men who discover their interests late in their academic careers from pursuing degrees in these areas (Moskal, 2000). Providing undergraduates with opportunities to go into engineering greatly increases the recruitment pool.

VIII. Learn more about different ways to improve your teaching.

Free, easy to use materials that can help improve your women students' achievement and continuation can be found at:

> National Center for Women and Information Technology: Post Secondary Education Practices. www.ncwit.org/practices.post.html
>
> The Chilly Climate: How Men And Women Are Treated Differently In Classrooms And At Work. www.bernicesandler.com/id4.htm

The overall goal is not just to decrease the gaps be they by gender or race/ethnicity. It is to reduce the gaps while all gain. The preceding can help you do that.

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