Women in Science, Math, and Engineering: How to Keep Them?

The statistics can be somewhat startling, while women receive 56% of BA degrees in the United States, they receive only 37% of the Science, Mathematics, and Engineering (SME) bachelor degrees (Chang, 1). As scary as the statistics on women are, they only point to an even bigger problem among all SME majors. According to one study, there is a 40% decline in the number of undergraduate science majors between the first and senior year of college (Didon, 336). Another study found that about 50% of the students who enter college in SME majors will change their major in two years (Change, 1). In a study of Hispanic American women who declared physical science or mathematics majors, 50% drop out within the first grading period (Ortiz, 1). The lack of SME majors has often been blamed on America’s high schools or even elementary schools, with university professors claiming students are not encouraged to consider science careers or are unprepared by their high school teachers. The statistics tell another story, no matter which specific numbers you consider, 50% in two years or 40% in their college careers, students are getting turned off from SME careers while in college, not high school. And the problem isn’t just with women; men are fleeing the sciences as well.

This decline in SME majors couldn’t be coming at a worse time. Studies show the U.S. will need 1.9 millions science workers over the next ten years (Chang, 1). All SME fields, especially physics, saw a rise in prestige, funding, demand, and research areas during the middle of the twentieth century. The space race was a major boost to the sciences as America saw the importance of a scientific education and scientific research. Many physics departments
expanding during this time. Almost fifty years later, many physics departments have found themselves top heavy, with most of their faculty only a few years away from retirement. With the decline in the number of new scientists produced each year many universities may have trouble replacing their retiring faculty members. Universities aren’t the only ones suffering; industry will also be hurt by the lack of SME majors. In an increasingly technology and science focused world America can’t afford to be without SME majors. As expressed by the former presidential administration, “twenty-first century economies will be based on how well nations use knowledge as a resource” (Directorate for Education, 1). Attracting and keeping SME majors from a variety of backgrounds is important for three key reasons laid out by the Directorate for Education and Human Resources. First diversity provides the number of scientists necessary to stay competitive in a global market. Second, a diverse workforce will provide problem solvers with the “diverse views required to address comprehensive solutions to modern problems.” And third a diverse scientific population “ensures that all groups in society are represented when decisions are made regarding the influence of scientific and technological advances (v). As the study goes on to point out, “diversity in SMET disciplines is vital because science depends on critical thinking about comprehensive solutions to problems. Creative and innovative solutions arising from new points of view and coming from different worldviews have the potential to further broaden scientific and technological horizons” (1). It is often said that to the man with a hammer, the whole world looks like a nail. Hammers have worked well to help us solve many of the problems we have faced as a scientific community, but there are many other problems that have yet to be solved. We could continue to pound away at them or we could admit that a wrench might be useful. We need to start bringing in people with wrenches. Attracting a wide variety of SME majors is important because we simply need more people and
we also need new outlooks. The old system worked well to attract a certain type of SME major, but apparently that type of students is becoming even rarer. It is time to find new ways to attract new types of students before the crisis becomes worse.

When discussing retention or attrition rates, there are two phenomenons that must be considered. The first is that a certain attrition (students leaving SME majors) rate is to be expected and is healthy. There are some students who were misguided about what a career in a SME field truly involved and who would honestly be happier some place else. The tendency among most faculty members, though, is to assume that the current rate of attrition falls into this acceptable range (Seymour, 234). The research tells another story, suggesting most students are leaving SME fields based on bad information or experiences. The other phenomenon is referred to by Elaine Seymour as the Iceberg problem (230). Her research and other similar studies suggest these high attrition rates are just the tip of the iceberg and that they hint at even larger problems within SME departments and, while not bad enough to make the remaining majors leave, are felt by all students.

The question is often asked, why focus on increasing the number of female SME majors and decreasing their attrition rates. Women make up an unusual minority group in the sense they are not really a minority except in the science classroom. They make up 50% of the U.S. population and are actually a majority of college graduates, a statistic that appears to only be increasing. Many people are also quick to point out that they can often provide a different viewpoint to that of the traditional male-oriented SME fields. Another important fact is that no study on programs to increase female enrollment and attrition in SME majors has yet to show a negative effect on male enrollment or attrition. In fact many curriculum changes have actually improved understanding in both men and women.
The first step in understanding how to attract and keep more female SME majors, is to understand why there are currently so few. There has long been an assumption that women don’t choose SME majors because they are hard male fields. Yet the same was true of law and medicine and women have made tremendous strides in those fields with the number of female students almost equaling the number of male students. The problem for most women in choosing SME fields is that they don’t feel these careers have any social value or relevance (Farrell, 31). Statistically most female students are interested in careers that will fit with their “orientation toward helping others and having a family” (Chang, 2). It is not that SME fields lack social value or relevance, the problem is that these things are rarely highlighted in the curriculum (Chang, 2). The problem is not that SME careers do not fit with most women’s value systems, the problem is that most women do not realize how SME careers can fulfill their desire to help society. Another reason for the high numbers of women leaving majors in science, math or engineering is the disconnect between why they originally chose these majors and their experiences in their courses. For students participating in an American Women in Science (AWIS) mentoring program, the top three reasons for their decision to study science were the fact that science is enjoyable and interesting (47%), science is challenging (12%), and a teacher encouraged them to study science (10%) (Didon, 336). For over half of the women in science majors, their attraction to science is based on the fact that it is interesting, fun, and challenging, yet very few introductory sciences courses would fit this definition (Didon, 336). It is not that SME careers aren’t fun or challenging, quite the opposite actually, or that introductory courses can’t be fun or challenging; for many of the women the traditional curriculum which focuses on memorization of formulas does not appeal to their desire for a big picture perspective before attacking the details. In a landmark study Elaine Seymour and Nancy Hewitt investigated the
reasons students left SME majors and the problems faced by those students who chose not to switch (Seymour and Hewitt). In an earlier paper Seymour summarized several of the results of the study. First, most problems sited by switchers arise from structural or cultural sources rather than personal inadequacy (234). In other words, students are not leaving SME careers because they can’t handle the course work, a fact Seymour and Hewitt’s work overwhelmingly proves. Actually there were no attributes of ability or character found which could distinguish the switchers from the non-switchers (232). Every trait or problem found among the group of switchers was also found among non-switchers. The only difference appeared to be the non-switchers learned ability to cope with the problems all students sited (234). The question then becomes how do departments teach their students these coping skills so that more students are able to fulfill their original intention to complete SME majors.

Just as there are many women who leave SME majors and many reasons that they leave, there are many ways to tackle the problem of encouraging them to stay. Especially in states where community colleges play a big role in the educational system, universities are working to identify and encourage students who showed an interest or aptitude in science while at the junior college level. These departments recognize the influence community college instructors at the introductory level can have on students. These institutions are attempting to support students as they make the transition from a successful life at a community college to a successful life at a four-year college and onto graduate school (Chang, 1). Some universities are choosing to totally rewrite their curriculums to make them more in line with the ways most women prefer to think. For instance, Smith College has a new engineering curriculum which focuses on the framework first instead of the equations. Real world examples and hands-on projects are part of the coursework long before junior year (Farrell, 31). As many of Smith’s once skeptical faculty
members can attest, this change in the curriculum doesn’t compromise the rigor of the major, but
does improve the learning that takes place.

The last two examples of improvements discussed here focus on addressing a common
need among women – the need for a supportive social network. A feature often commented on
by non-science majors is the lack of interaction between students in traditional science classes.
Not only is the typical lecture class a one-way street of communication running from the
instructor to the student and rarely the other way, but students rarely discuss among themselves
(Tobias, 22-23). This lack of community can lead to feelings of isolation and unhappiness with
the course and unrealistic expectations of what is expected. The first change which addresses
this issue is the increase in collaborative group work that is happening at many universities. This
increase in group activities is often not originally done to increase social networks but it has been
shown to have that effect. Group work allows students to tackle more real-world problems in a
more lifelike setting. These changes have been shown to increase student understanding of the
material. They have also been shown to increase the students’ social network, an important
support for all students, especially underrepresented students such as women (Chang, 2). These
programs have been shown to successfully increase both female enrollment and retention
(Chang, 2). A second approach aimed directly at combating the lack of social networking among
SME majors is mentoring. Mentoring can be defined as the informal mechanism by which
students learn the structure and the function of the scientific establishment (Didon, 336).
Mentoring can exist on many levels; upper-level undergraduates mentoring first year majors,
graduate students mentoring undergraduates, professors mentoring undergraduates, or successful
industry workers mentoring SME majors. Mentees do not always have to be undergraduates
either, though this is the kind of relationship that will be focused on here. It can often be helpful
for graduate students and new professors to have mentors “show them around” their new role.

Mentoring can be done in a one on one session or in larger groups. These mentoring relationships have been shown to help students by socializing them to the SME fields, providing a social network, and increasing students’ self-confidence and feeling of worth to the field. These kinds of relationships have been shown to increase retention of women in SME fields (Chang, 2). Eighty-three percent of science majors surveyed see themselves married in 10-15 years. Eighty-three percent also see themselves with full-time careers as well. Most of the students surveyed also intend to have two or more children by the time they reach this period in their lives (Didon, 336). These women will need to learn to balance a career and a family. The large number of students who leave SME fields because they have rejected the SME lifestyle (Seymour) shows than many students don’t feel this balancing act is possible. These women need to be exposed to female scientists who have successfully balanced a family and a career (Didon, 336). Of the women who went through a AWIS mentoring program, 61% felt it helped them deal with the barriers that were preventing them from entering or staying in a science major (Didon, 368). This is not to say that mentoring is only successful for women SME majors. Male students can also benefit greatly from mentoring relationships. These relationships help to provide an accurate picture of both the SME lifestyle and research fields.

The attrition of possible SME majors should be a major concern for universities and could soon become an economic problem. There are many ways to stop this problem, a few have been mentioned above. The most far reaching option is to counteract the lack of social networking among future and current SME majors. The most efficient way to do this is through mentoring programs. Without trying to change the science background of students, or overhauling the curriculum, universities can make a major difference in the way students view
their role in the department and the field. Mentoring programs allow students to understand what it means to do research, learn how to navigate the system, and create reasonable expectations of themselves and their courses. A mentor acts as both a guide and a sounding board, for students as they navigate through the early decisions that can often have major impacts on their future careers. Mentors provide advice on courses, instructors, and research opportunities.

Unlike curriculum changes, which can be costly and, despite recent computer advances, are not individualized, mentoring relationships a very flexible. Since the relationship is negotiated by the mentor and mentee it can be designed to fit the individual needs and styles of everyone involved. Mentoring is still time consuming and requires a commitment from everyone involved. Mentoring will not guarantee that a student will never leave a SME major, but it can ensure that the student makes a decision based on more accurate information than before.

There are two types of mentoring which are equally important and which serve different functions. First are group mentoring activities. These are activities in which groups of faculty members, graduate students, and undergraduate students meet for both structured discussions and informal interactions. This allows undergraduates to discuss issues among themselves and to realize they are not the only ones going through certain experiences. This also allows these undergraduates to learn from the experiences of older members in the department. These meetings can also have the added benefit of helping faculty members understand the issues their students are facing. While mentoring can be helpful for all students, it is important that underrepresented students have an opportunity to share their opinions with each other in a setting where they don’t have to worry about members of the majority ridiculing or dismissing their experiences and feelings.
A second type of mentoring relationship is a one on one relationship. This relationship could have been arranged formally by a mentoring program, or could have grown spontaneously out of other interactions. If an administration wishes to encourage one on one mentoring it is best to create some type of program if for no other reason than training mentors instead of simply encouraging spontaneous relationships. This relationship helps students handle both the more mundane day to day activities of their academic careers such as deciding where to go to get help and how to fill out paperwork, as well as the more personal major decisions such as what type of research to pursue, if and how to apply to graduate school, and whether or not to change majors. The mentor in this type of relationship provides advice, a safe place to share thoughts, and a model of a successful SME career. It is not necessary that the mentor have all the answers, otherwise no one would be qualified. The mentor only needs to be capable of listening and guiding the student to the necessary information, the person with the information, or the person who would know the person with the information. Though time consuming, this type of relationship has been proven to be key in keeping students in SME fields. Many successful people in SME careers, especially those from underrepresented groups, can quickly point to a mentoring relationship that they credit as crucial to their success.

Mentoring relationship can develop spontaneously based on nothing more than an agreement between mentor and mentee or they can be organized and supported by the institution. For successful relationships to be the norm in a department and not simply lucky anomalies it is important the administration to openly support them using more than just words. This means departments or institutions should provide training for mentors, information to mentees about how to find mentors, and some sort of compensation for the time necessary to be a mentor. This type of compensation could be in the form of decreased teaching load or increased research
funding especially for undergraduate research assistants. It is also important the administrators recognize people that excel in mentoring. Mentoring should be seen as just an important part of faculty life as teaching, research, and service and it should be rewarded accordingly.

America is facing a problem in the startling loss of so many capable future scientific workers. The only way to stem the flood of students leaving future SME careers is to attract a larger and more diverse pool of students and to work to keep these students in the field. This means making SME careers and majors more attractive to a broader spectrum of students. This must be done without sacrificing the standards of current curriculums. Research has shown this is possible. Mentoring is a way to change students’ experiences in SME majors without necessarily changing the curriculum.
Works Cited


Tobias, Shelia. They’re Not Dumb, They’re Different. Tuscon, AZ: Research Corp. 1990.