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ABSTRACT

This handbook arose from a project that was designed to examine the role that science education plays in the under-representation of women in science. It is based on case studies of introductory science classes, surveys of syllabi and textbooks used in science classrooms, a survey of the literature on the history of women in science and current research on gender in science education, and interviews with male and female science faculty. This handbook describes aspects of culture that researchers believe contribute to the attrition of women from science, mathematics, and engineering majors and gives concrete suggestions for addressing each of these issues. It aims at helping faculty members become more aware of the issues that affect women in science and providing them with ideas on how to address these issues in their own classrooms. Topics discussed include observing classroom dynamics, personalizing large classes, shifting from a competitive to a cooperative model, considering a variety of examination options, encouraging active participation in labs, fighting narrow stereotypes of science and scientists, providing diverse role models, making oneself available, and fostering self-confidence. Contains 40 references. (JRH)

Achieving Gender Equity in Science Classrooms

A Guide for Faculty

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PREFACE

The idea for this handbook originated in a Group Independent Study Project (GISP) on gender distinctions in science education at Brown University. The GISP, organized by students concerned about the under-representation of women in science, was designed to examine the role that science education plays in that under-representation. The GISP's goals were to determine the causes of high attrition rates in the undergraduate "pipeline" in science, math, and engineering for women, and to find solutions to decrease the number of students leaving these fields. The GISP's work included case studies of introductory science classes at Brown, surveys of syllabi and textbooks used in science classrooms, a survey of literature on the history of women in science and current research on gender and science education, and interviews with male and female science faculty.

In order to examine issues of science education and women in science at other schools, students in the GISP assembled a conference of students from the New England Consortium for Undergraduate Science Education (NECUSE) schools in April 1993; NECUSE supports science education efforts at sixteen colleges and universities in New England. Further consultation with NECUSE faculty members occurred at a second NECUSE meeting on women in science held at Middlebury College in January 1994 and at a third NECUSE-sponsored meeting on Minorities in Science Education held at Smith College in January, 1995. This handbook was produced with funding from NECUSE.

Further input on this handbook came from faculty and staff at Brown University who have been involved in a Sloan Foundation seminar series on inclusiveness in science education. Funding from the Sloan Foundation has also helped to support other initiatives to improve science education and to increase awareness of issues concerning gender and race in science at Brown; these initiatives have included science curriculum development by faculty, student-faculty collaboration to redesign science courses, and informational visits to individual science departments. Feedback and experiences from all these programs contributed greatly to the ideas found in this handbook.

INTRODUCTION

Attrition of women from science is well documented. (NSF, April, 1989. Siebert 1992. NRC 1991.) Although both men and women leave the "pipeline" along the way, studies have repeatedly shown that a higher percentage of women leave, especially during the undergraduate years.

A common assumption is that students who leave the sciences are less able in the sciences than those who continue. The number of students graduating with SME (science, math and engineering) degrees is therefore believed to be determined by the quality of the students within the pipeline. However, many studies have shown that ability is not always the deciding factor in determining a college major.

> *Switchers [from SME fields] and non-switching seniors did not appear to differ ... in ability. They shared strong similarities in their self-reported mean GPA scores (Seymour 1992b).*
>
> *Most switchers did not have more conceptual difficulties with science and mathematics, or inclination to work less hard, than the non-switchers (Seymour 1992a).*

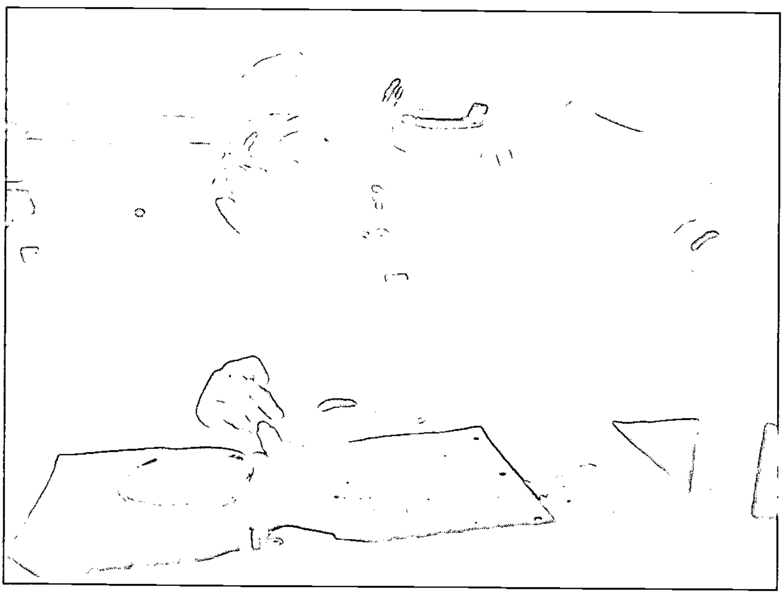
A number of factors contribute to the high attrition for women (and under-represented minority men) in science.

> *Aspects of the structure and culture of SME [Science, Mathematics and Engineering] departments and engineering schools inadvertently encourage attrition and impede retention efforts, for the whole student population and for important subsets of it (Seymour 1992a).*

In this handbook we describe the aspects of culture that researchers believe contribute to attrition from SME majors, and we give concrete suggestions for addressing each of these issues. If implemented, these changes may prevent very capable students from leaving the sciences and may also attract students initially not involved in the sciences. We hope that this handbook will help faculty members become more aware of the issues that affect women in science and will provide them with ideas on how to address these issues in their own classrooms.

Many of the changes suggested here are based upon sociological, psychological, and educational research on gender differences with regard to science learning and attrition from science. To the authors of this document, these differences imply that to teach for equality we must first recognize that teaching habits differentially affect various populations in our classrooms.

It has been argued by many educators that by using teaching techniques that recognize a variety of learning styles in our classrooms, we would not serve only women but would attract more students, including men, who are not learning under the standard lecture-style, large-class, science education system. Some faculty who have considered the challenge of teaching for a more diverse "audience" have claimed that more inclusive teaching is simply good teaching. We believe this to be largely true, with two caveats. First, some suggestions (such as out-of-classroom strategies) have less to do with good classroom teaching and more to do with creating a welcoming climate. Second, by concentrating on good teaching alone, we often ignore gender-related differences.



OBSERVE CLASSROOM DYNAMICS

PROBLEM

Studies have shown that there are gender differences in communication styles in the classroom (Hall 1982). In general, men tend to respond to questions more confidently, aggressively, and quickly, regardless of the quality of their responses; they tend to speak more freely and spontaneously in class, formulating their answers as they speak. Women, on the other hand, tend to wait longer to respond to a question in class, choosing their words carefully, reflecting on the question and constructing an answer before they speak.

These studies have also shown that women tend to be interrupted more frequently than men; when this happens, they get the message that their contributions are not as valuable, and they may hesitate to join discussions in the future.

RECOMMENDATIONS

- **Encourage class participation:** Allow a wait time before choosing someone to answer a question. Studies have shown that by waiting another *two or three seconds*, uncomfortable though it seems at first, it is possible to encourage more students to participate in questions and answers.
- **Whom do you call upon?** Be aware of whom you are calling upon, and how you respond to their questions and answers. Studies have shown that lecturers tend to call on men more frequently than they call on women, and that they react more positively to the responses of men, including coaching their answers. Self monitor, or have someone else monitor the number of men, women, and people of color who speak in your class. The results are often startling, even for lecturers who are aware of gender (and race) biases.
- **Seek outside feedback:** Ask someone from your college's education, communication, speech, or theater departments or the college teaching center to observe your class and give you feedback about lecture style and the dynamics of the classroom. It is difficult when lecturing to concentrate on the content, delivery

and patterns of interactions with students. A trained observer can give you valuable feedback about ways to include and encourage all students. Some institutions have found it useful to train undergraduates to act as classroom observers. Another way to monitor your teaching is to videotape yourself during class and then review the tape later.

- **Monitor language and materials:** Use gender neutral language, refer to female as well as male scientists, and attempt to learn students' names. Include material that reinforces your support of women in science, whether it is a journal, a magazine or a book on gender and science research. This may provide female students with a greater feeling of connection and inclusion.
- **Pose a question:** Some faculty pose a question at the end of a class, announcing that this question will start the next class discussion. This technique extends the time for reflection by those students who are willing to capitalize on the opportunity.

PROBLEM

When students were asked what they disliked about large classes, women tended to respond that such courses were impersonal, that the professor didn't know who they were, and that they felt isolated. In a study of "Student Perceptions of Problems In Undergraduate Teaching Methods by Sex" (Hewitt 1991), thirty percent of women surveyed listed "professors don't care about you" as a problem, but no men listed this as a problem. Students were also asked to give characteristics of a good professor. Many women replied that a good professor was approachable, friendly, and wanted to know the students. Often, because women are used to direct encouragement and personal feedback from high school teachers, upon reaching college they feel that learning is more difficult as a result of a lack of close contact with faculty (Seymour 1992b).

The size and demographics of a college science class may be quite different from what students experienced in high school. It may be hard for women to make friends with the men of the class when they find themselves in the minority. As a result, there can be a level of formality and awkwardness in the classroom which deters women from asking questions. Even asking what students may deem to be "stupid" questions is a much less daunting prospect when surrounded by friends.

RECOMMENDATIONS

- **Encourage the use of study groups:** Study groups let students know they are not alone and allow students to process material more thoroughly by explaining it to others. "Cooperative small group work is a more effective strategy both for achievement and motivation" (Gardner et al. 1989). By cutting down on the competitiveness in a class and encouraging cooperation, study groups can be especially beneficial to women. "A necessary element for women's success in engineering programs at Massachusetts Institute of Technology was providing a peer group or team with whom they could cooperate" (Dresselhaus 1987).

  Encouragement of the use of study groups can be done by simply stating at the beginning of the course that study groups are encouraged, or by assigning projects or lab work to be done in groups. Another option may be to give an assignment early in the semester for which consultation among class members is highly encouraged, or even required. This may provide the push necessary to start students working together and to stay working together for the remainder of the course.

- **Create a better sense of community:** Professors and students might consider ways in which the students can get to know one another better in the classroom in order to foster a better sense of community and camaraderie. Work in groups, such as those mentioned above, provides one such opportunity. During class, have students discuss a question with their neighbor for a few minutes before you ask for responses; not only does this give students time to think through their ideas more clearly, but it also allows them to meet other students.
- **Use more writing exercises:** Use writing as a tool for understanding and cooperative learning. For example, have students write for their fellow students, providing specific directions for a simple task, or providing an explanation of a difficult concept for their classmates. This will help foster greater communication within the class while emphasizing that clear writing is essential in science.
- **Rearrange the classroom setting:** If possible, rearrange the structure of the classroom seating. Set up desks in a U-shape or, for smaller classes, seat students around tables. This can introduce a level of informality and personal connection to the classroom. Modifying the way space is used so as to minimize the distance (physical and mental) between the professor and the students may also foster a better sense of community. Moving around the room during class also allows for increased contact with students..
- **Start an e-mail list:** Start up an electronic discussion list. Make it possible for students to ask anonymous questions. A chemistry professor at Brown University who started an electronic discussion list for his class found less of a rush at his office hours around exam times; when he asked his students why, they said that the discussion list had provided them with the opportunity to get

most of their questions answered (by the professor, TA's or other students) throughout the semester instead of waiting to ask them all at once.

- **Use undergraduate teaching assistants:** Using undergraduate TA's helps those students to gain more confidence in their own abilities, and an undergraduate TA may seem more approachable to other students in the class, especially female students. However, it is important to remember that some TA's may simply reinforce gender stereotypes and may therefore be counterproductive; always educate your TA's about these issues and issues of appropriate boundaries, and monitor the classroom dynamics in their sections or labs.
- **Provide opportunities for the students to meet outside of the classroom:** Some teachers have found it appropriate to invite small classes, groups of undergraduate TA's or large classes divided into sections to their homes or labs either for informal discussions about their field or for a discussion section of the class. This provides students with the opportunity to get to know each other as well as the professor in a more informal environment.

SHIFT FROM A COMPETITIVE TO A COOPERATIVE EDUCATIONAL MODEL

PROBLEM

It is a common belief among first-year students that introductory science classes are "weedouts," and that such courses are designed to eliminate those students in the class who are not deemed "fit" to be in science. The perception of a "weeding out" atmosphere discourages many interested students from pursuing science in college. Some faculty members believe that "a lack of certain attributes of ability and/or character distinguishes those who leave SME majors from those who remain in them. Widespread acceptance of this theory allows SME schools and departments ... to regard their leaving as a kind of 'natural selection' process" (Seymour 1992). In fact, studies have repeatedly shown (Astin et al. 1987, 1988.

Green 1989. Seymour 1992a.) that many students who leave the sciences are intelligent and strongly motivated, but are discouraged by the competitive atmosphere and the belief that the department is trying to judge their abilities at an early stage. Although many classes are designed to set students in competition, students often respond more positively to an atmosphere of cooperative learning. In her research, Elaine Seymour found that over a third of the students switching out of a science, math or engineering field indicated that one of their primary reasons for leaving was that their "morale was undermined by competitive culture" (Seymour 1993).

Cooperative learning is an approach to learning which uses small groups of students working together to solve problems, complete a task or accomplish a common goal. "Small groups provide a forum in which students ask questions, discuss ideas, make mistakes, learn to listen to others' ideas, offer constructive criticism, and summarize their discoveries in writing" (NCTM 1989).

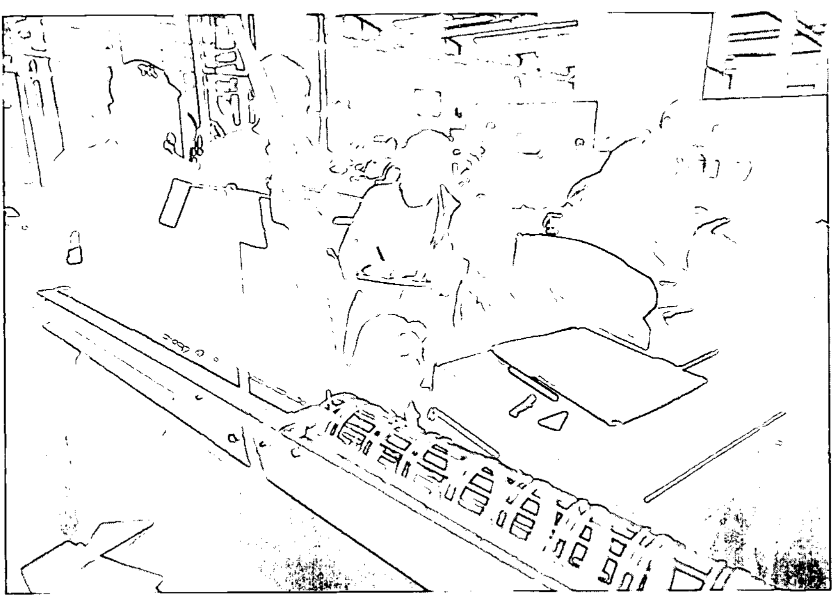
RECOMMENDATIONS

Faculty who teach introductory science courses should address the weedout perception so that students are not "scared away" from science for reasons other than their abilities and interests. By shifting the pedagogical focus away from a competitive, "weeding out" model to a cooperative, welcoming, and stimulating model we are likely to retain more talented students. There are several ways to shift this focus:

- **Address the weedout theory:** Some engineering professors at Brown University have found it useful to talk to classes about the weeding out theory, explaining to them that the admissions process was the weed out and that they expect all their students to do well. If a professor has confidence in and high expectations for a class — and tells the class that — students often have more confidence in their own abilities and perform better.
- **Change the grading system:** Do not grade on a curve; instead, use a criterion or competency-based grading system. Grading on a curve forces students to compete against each other for grades; if one student scores very high, this automatically results in other students getting lower grades. Since their grades are relative, students may be more hesitant to help each other or to work in study groups which could enhance their own learning. At the

same time it can be useful to give students a handout clearly explaining the goals of the course and your expectations.

- **Encourage use of the pass/fail option:** Encourage apprehensive students to take the course pass/fail; this allows them to explore a subject of potential interest without having to worry as much about the grade. It also allows them to base decisions about their future on how much they are learning and their interest in the subject matter instead of basing decisions primarily on a numeric grade too early in their academic career.
- **Address grade anxieties:** Stress that performance in introductory courses is not necessarily an indicator of future performance or ability. Students must be aware that low grades in introductory science courses can be the result of a combination of reasons — such as a weak high school science background or difficulty in making the transition to the college environment — many of which may have nothing to do with science ability.
- **Utilize cooperative and collaborative work:** Design introductory courses that are more discovery-oriented and cooperative, and explore interesting topics while not ignoring the "basics."



Encourage the use of study groups, both formal and informal, in-class and out of class (see Personalize Large Classes, pg. 9). Encourage the student-as-learner/teacher-as-coach model. Help students to see that science is not static, that there are questions to be answered, and help them to develop critical thinking skills and group-work skills which are used everyday in research by scientists. Have them design their own lab to address a question they have about a topic that has come up in class or about a topic which is implicit in the scope of the course. (See Works Cited and Other References for references on cooperative and collaborative learning.)

CONSIDER A VARIETY OF EXAMINATION OPTIONS

PROBLEM

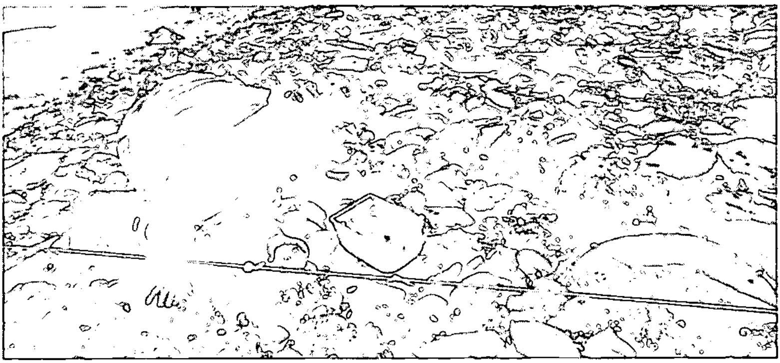
Exams in college are usually graded on a curve. Students in introductory science courses often panic and become discouraged when they receive their first exam grades, not realizing that there is a scale. Grades that are in fact above average may appear to be "bad" especially in comparison to grades received in high school. Women in particular "may develop extremely, perhaps even excessively, high standards for themselves as a prerequisite for staying in science" (Ware et al. 1985).

Students' different learning styles may also cause them difficulties with exams. A student's performance on an exam is not only an indicator of the student's understanding of the course material but also of the student's response to a particular exam style and time constraints.

RECOMMENDATIONS

- **Explain the grading system:** Before students receive their first grades the professor should explain how his or her overall grading system works and whether the exams are graded on a curve, to avoid any undue anxiety. Clearly state the overall goals and expectations for students.

- **Eliminate the curve:** Some professors find it effective not to use a curve at all and instead give students at the beginning of the course the total number of points they must attain for a particular grade. This system helps to eliminate competition among students and creates a more amicable classroom atmosphere and encourages studying in groups (see also: Change the Grading System, pg. 12).



- **Give a word of encouragement:** An easy, yet effective, strategy for professors to undertake is to write a word or two of encouragement on students' exams — including those students who did not do well. A professor can also easily take a student aside and ask if she or he has thought about graduate school. These things take only a minute or two and can make a world of difference to any student. Many scientists have reported that such small yet pivotal experiences helped change the course of their lives.
- **Follow up on poor exam/lab performance:** Request that students who scored below a certain grade meet with you during office hours, or with a TA or knowledgeable dean. This could provide the student with the opportunity to explore why they think they did poorly and to discuss different study strategies for the future. This also provides the opportunity for certain students to be directed to campus tutoring facilities, study skills support programs, or learning disability resources that students may have previously been unaware of.

- **Consider untimed or take-home exams:** Alleviating the time constraints on exams may help reduce students' stress and emphasize logical, ordered thinking and more in-depth analysis of material.
- **Vary the exam structure:** A combination of multiple choice, true/false, mathematical problems, short essay questions and long essays may provide students with a better opportunity to demonstrate their understanding of the material in the course by allowing them to present their knowledge in a variety of formats.

ENCOURAGE ACTIVE PARTICIPATION IN LABS

PROBLEM

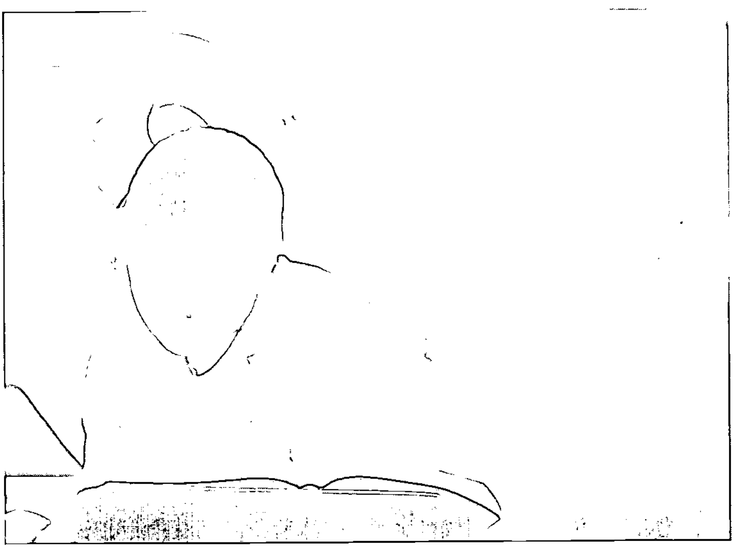
Women tend to be more passive in labs at coed colleges. This may be due to gender differences in socialization (whereby boys are more exposed to mechanical toys than girls). Observations of women at women's colleges indicate that they become more engaged in labs than their counterparts at coed colleges, suggesting that greater encouragement by faculty and careful planning of lab teams can increase engagement by women in labs.

While labs give students the opportunity to apply their knowledge of the subject, students often fail to see the connection between lab and lecture. As a learning tool, students expect labs to reinforce the material learned in lecture.

RECOMMENDATIONS

- **Divide lab roles:** Assign roles (such as note-taking and taking measurements) to each member of a lab group and rotate the roles.
- **Emphasize lab/classroom connection:** The correlation between what is learned in lecture and what is to be carried out in lab should be stressed by the professors and the teaching assistants. If the connection between the lab work and the coursework is explained (to teaching assistants as well as students), the lab work may help some students understand the coursework with which they may be having difficulty. Some concepts may even be much easier to get across in lab than in lecture.

- **Show connection to current research topics:** Showing the correlation between actual research in the field and their current lab and/or coursework can encourage more interest in the field of study. Professors should encourage independent lab study, and (if possible) spend a class showing the students around their own research labs.
- **Provide an open-ended structure:** Give introductory labs a more open-ended structure. The student is forced to think about the lab rather than follow "canned" instructions to already known answers. Emphasize the path to the solution, not just the final answer, and encourage students to share the diverse paths they have taken to get to solution.
- **Have students design labs:** Give students a topic or issue they must explore through a lab exercise and have them design the exercise themselves. This exercise may give students a sense of "ownership" of the lab which may help to motivate them to participate more actively and which may help them gain more confidence through the experience. Having students design the lab themselves may also enable them to gain a better understanding of the topic or problem being addressed.



FIGHT NARROW STEREOTYPES OF SCIENCE

PROBLEM

Students are deterred from considering science as a career because of negative or narrowly defined images of scientists presented by the media and society in general. When hundreds of ninth and tenth graders were asked to draw a scientist, almost all drew pictures of a "nerdy" white male with a beard and glasses wearing a white lab coat (Gardner et al. 1989). With limited images of women as scientists, it is hard for young girls and women to imagine themselves in the field. On the other hand, knowing a scientist personally may make a woman much more likely to pursue her interests in the sciences: in an informal survey by the GISP at Brown University, the most important factor determining whether a woman will pursue science as a career was the vocation of her mother and or father.

Many people also have negative and narrow images of science as a discipline, career or a course of study. Many young people see the study of science (not medicine) as leading primarily to a field in the military. This is illustrated by numerous examples drawn from the military in college textbooks and in the media's portrayal of science. While this may be a positive connection, it probably appeals to more men then women and may give the impression that science has a very narrow range of applications.

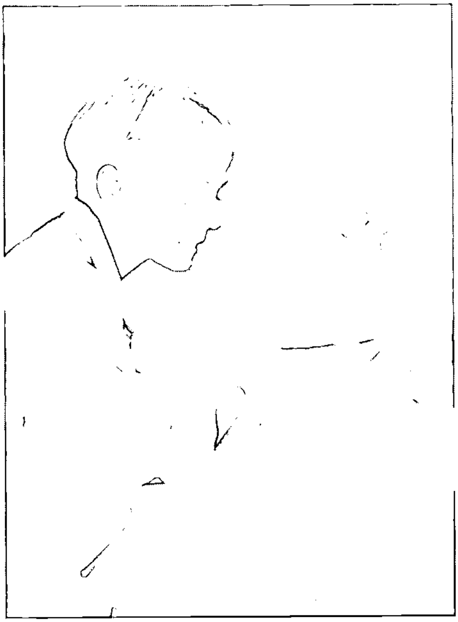
> *The positive benefits of S&E [science and engineering] research and development have not been the primary focus of the public image, nor have science and engineering been viewed by the public as ennobling careers (NAS 1989).*

Students frequently believe that science classes are too difficult and too time consuming, without seeing the potential benefits of science or where a particular science course fits in the "big picture." This deters some students who are undecided in their area of study from ever taking a science class.

RECOMMENDATIONS

It is difficult to counter stereotypes that are so ubiquitous. Nevertheless, some steps can be taken:

- **Applications of science:** To shed a positive light on science, professors can show applications of the coursework so the students



can connect what they are studying to the "real world." One physics professor at a NECUSE school altered the examples used in class so that the problems he presented were based on a mix of scenarios that were accessible to a range of students. He limited both the number of military and sailing examples, believing that they reflected neither the interests nor experiences of most students.

> *Science education should ... emphasize life learning and life skills. The perceived relevance of scientific process and content to everyday life experiences is a factor in science interest and participation at both the pre-college and collegiate levels (Gardner et al. 1989).*

Labs and sections are often an effective place to stress such applications if they relate directly to the coursework (See also Encourage Active Participation in Labs, pg. 16).

- **Show alternatives to and within academic careers:** Faculty at four-year colleges tend to only invite faculty from other academic research institutions to give colloquia. Consider also inviting scientists who work in government labs and industry, as well as people who majored in science and went into other careers for which a solid understanding of science can be valuable, such as law, education, science writing, and public policy. Speakers may also be willing to meet with classes or to present less technical lectures to undergraduates.

- **Discuss the value of a science education:** Talk to your students about your views of science in general. Discuss the skills one gains while pursuing an undergraduate science degree and how those skills relate to life skills. It may also be helpful for students to hear about the value of undergraduate science training even for those students intending a career in a very different field.
- **Outreach to primary and secondary schools:** To confront these stereotypes when they form, some professors and undergraduates participate in science workshops and outreaches for elementary and secondary school students. Not only does this work to change stereotypes at a young age, but it can also help the college students gain more confidence in their abilities by enabling them to see themselves as role models for younger students.

PROVIDE DIVERSE ROLE MODELS

PROBLEM

Women need exposure to male and female mentors for all the reasons stated in previous steps. Many undergraduates and women in science cite the importance of their male role models or mentors in assisting them in their pursuit of a science career. While men have been important colleagues, advocates, role models, and mentors for women scientists, women students also need exposure to women who are successful in SME fields. It is still a long held belief that,

> *The 'old boy network' which draws promising male students into research projects and mentored relationships with faculty ... tends to exclude women (Seymour 1992b).*

In addition, there are a lack of female and male role models in science who have successfully balanced work and outside interests. Often college women are *thinking ahead to their hopes for children and a family, but cannot find many role models who are women and mothers, and who manage to balance the needs of both job and family life. More and more undergraduates, both men and women, are looking for examples of scientists who pursue interests outside of the lab without sacrificing their careers.*

RECOMMENDATIONS

When students see people like themselves in a field, they are much more likely to create goals for themselves within that field because it appears more accessible. Women students need exposure to women with a variety of life-styles who are successful in SME fields so they can believe science is accessible to all, especially people like themselves.

- **Female faculty:** Ultimately, the best solution is to hire — and retain — female faculty who can serve as role models. Women faculty members who have families can also choose to share their stories about balancing work and family. "The faculty are very important in creating an environment that is supportive of women students" (Finholt 1990). According to the National Resource Council, "the presence of women faculty at all ranks" would be "a signal to women students that they will be respected and treated fairly" (NRC 1991).
- **Utilize women TA's:** While increasing the number of women faculty takes time, employing women graduate and under-graduate teaching assistants can be done more quickly. Also, make sure that your TA's recognize the importance of their role in students' learning experiences.
- **Guest lecturers:** Professors can provide role models for students by bringing guest lecturers to class to talk about their experiences in science or to give a lecture in their field of expertise (NRC 1991). Female scientists, including post-docs and graduate students from other universities, government and industry, can be invited to give colloquia as part of a department's regular colloquium series. Many speakers will also be more than happy to meet with a group of female students before or after the talk. Both male and female students from the introductory or intermediate level science classes can be invited to attend the talk.

- **Acknowledge women's contributions to science:** Mention the contributions of both female and male scientists when appropriate. Instead of simply mentioning a scientist's last name, include the first names of women scientists so that students do not assume you are referring to a man. A textbook with pictures, not just brief mentions, of women scientists can also make a very positive impact on students. It is true that choosing a good textbook can be a tricky process. In a study of textbooks by Jane Butler Kahle, "women, for example, were ... pictured in approximately 50% of the illustrations. However, their meaningful contributions were seldom cited or referenced" (Kahle 1985). For more information on the historical contributions of women to science, see Margaret Rossiter's 1982 book, *Women Scientists in America: Struggles and Strategies to 1940.*
- **Act as a role model and mentor:** Professors themselves are in positions to be excellent role models. Try meeting with students or groups of students informally. Talk about how you became interested in science, your life as a scientist, and whatever you feel comfortable revealing about your personal life. A teaching assistant can serve as liaison to help arrange an informal meeting.

MAKE YOURSELF AVAILABLE

PROBLEM

Some students perceive that faculty are too busy to talk or meet with them. In a study by Nancy Hewitt and Elaine Seymour, 12% of men and 20% of women indicated that "professors have no time for students" citing this as a problem in undergraduate science courses (Hewitt 1991). Conversely, many of the professors interviewed by students in the GISP project did not feel this was the case. The faculty complained that very few students came to office hours even though this was time intentionally set aside for their students. It may be that professors are not communicating their interests accurately or adequately to the students. However, a professor's willingness to provide help is not the only factor influencing a student's decision to seek help from any particular faculty member or graduate TA. There are often other factors present that ultimately deter students from getting the help they need.

RECOMMENDATIONS

- **Make yourself accessible:** Remind students throughout the semester that their questions and visits are welcome so they don't feel that the short mention of office hours on the first day of class was only a formality. Give students an e-mail address where they can send questions. Also, encourage students to utilize their teaching assistants for help and then stay in close touch with those assistants for feedback about what they are hearing.
- **Leave the door open:** Leave your door open, literally. Sexual harassment is of real concern to women in science; it is important to create an environment of mutual respect, free from intimidation and bias. Leaving your door open sends a message that the conversation is not private or of a personal nature. Let the student decide when to shut the door as it is sometimes appropriate to discuss test scores or course standing in private.

  Also, arriving at a closed door during "open hours" may make students feel that they are interrupting you, even when they arrive during office hours.

- **Require a student visit:** Require an office visit from each student in the first two weeks of class, just to make sure that every student gets introduced to her or his professor. This could also be a good opportunity to get to know something about the students as individuals, such as why they are taking the course and where they see themselves going in the future.

FOSTER SELF-CONFIDENCE

PROBLEM

Women in our society often have an extrinsic sense of self worth; that is they have a tendency, more so than men, to place a higher value on what others think of them. In addition, women are "more likely to fix the blame internally — to cite their own inadequacy as the source of difficulty" when encountering problems; whereas "men [tend] to place responsibility for difficulties outside themselves" (Ware et al. 1985). A male student's response to a poor test grade, therefore, may be to blame the examination as a poor judge of his knowledge or to blame the professor for inadequately preparing him for the examination.

Women are more likely to believe they are unintelligent when they receive just one bad exam grade and are in general less confident of their performance. Subsequently they make important decisions, such as the decision to change majors, based on either an inaccurate appraisal of their performance or on an insufficient amount of data, such as one poor test grade.

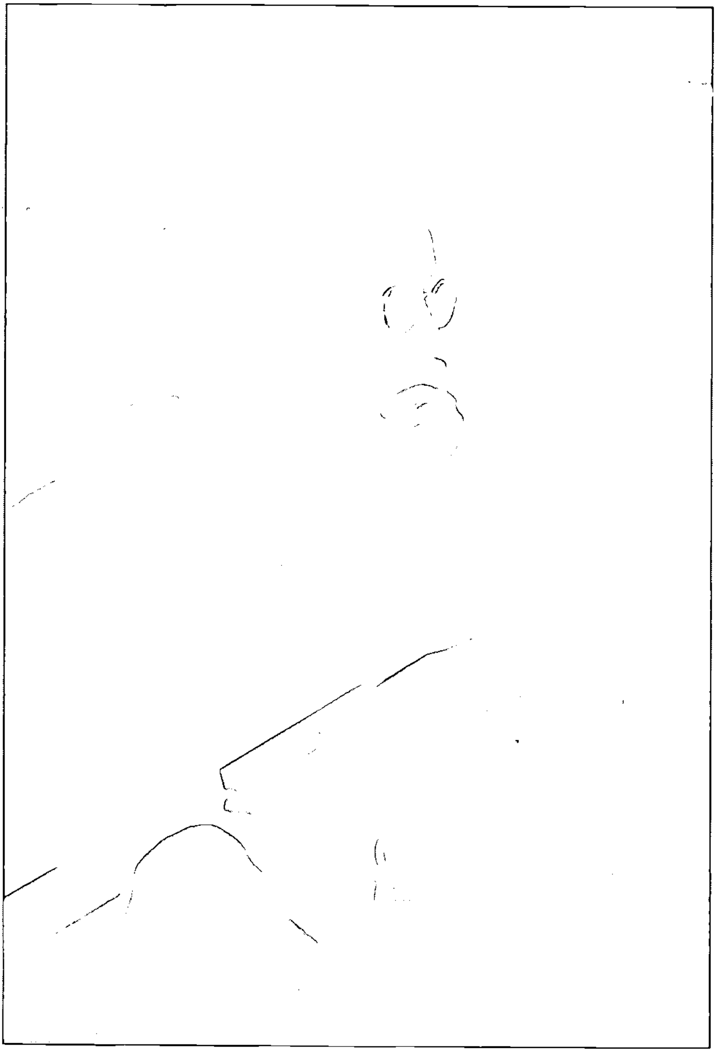
In fact, in a study of undergraduate biology majors, Marsha Lakes Matyas determined that the women in her sample had higher average GPAs than men, but dropped the major at a greater rate because of personal factors (Matyas 1988). Between 70% and 80% of females who switched out of the science track felt discouraged and suffered a loss of self-esteem even though their grades were the same as those of men (Seymour 1993).

RECOMMENDATIONS

- **Provide personal encouragement:** Be aware that women will be more likely than men to perceive their performance as less satisfactory than it is in reality, and they are more likely than men to attribute this supposed unsatisfactory performance to themselves. Provide encouragement to students and suggest opportunities for summer research, either at the university or at a summer program sponsored by another university or lab. Remember that even small words of encouragement can have a powerful positive effect on a student and are remembered for years.

- **Provide experiences that foster students' confidence:** Women's success in science can be influenced by an environment that fosters self-confidence. Self-confidence in the science classroom is bolstered by providing a variety of participatory experiences. At Alverno College, an all women's college in Milwaukee, "science classes, particularly the introductory ones, are structured around cooperation ... this shows our women that they can do science. It gives them the self-confidence to continue on" (Alper 1993). Science faculty at women's colleges realize the importance of women handling the lab equipment; at coed institutions women often watch as their male classmates conduct the experiments.
- **Provide research opportunities:** Summer or academic-year research opportunities often allow students to get a better sense of the purpose of what they are learning in the classroom. A research project may also help students to recognize skills and abilities that may not have been utilized in their classroom experiences. Positive outside experiences can help increase students' confidence in their ability to "do" science. Working with a faculty member or other researcher also provides students with the opportunity to find role models and mentors and to develop a better sense of what a research career in science would entail.
- **Form a Women in Science program at your school:** Good support systems for women can increase the percentage of women graduating with degrees in the sciences to higher than the national average. For example, in 1989-90, 24% of the engineering graduates at Purdue (which hosts a strong program for women in engineering) were women, compared to the national average of only 15%. These programs can address many of the personal and

academic issues affecting women in science, such as alleviating feelings of isolation, helping women to form support and professional networks, and providing mentoring opportunities. Talk to faculty and administrators in the Dean's Office, or at the Women's Center, about establishing a Women in Science Program that can provide co-curricular support for women.



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