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WHY SO FEW YOUNG WOMEN IN MATHEMATICS, SCIENCE, AND TECHNOLOGY CLASSES?

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Why So Few Young Women in Mathematics, Science, and Technology Classes?

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Many factors influence the success of women in scientific and technical careers. Women represent over 50% of the U.S. population, yet less than 16% of women are employed in scientific and technical careers. Research over the last decade makes it clear that disparities exist in the participation, achievement, and attitudes of young men and young women in science classes. Young women are as interested in science experiences as young men up until age nine. After that age, the number of young women interested in science, mathematics, and technology classes drops. Not enrolling in science and mathematics classes in high school limits career options for young women, and their chance to succeed in a scientific or technical field becomes remote. Why is this happening? What can we, as educators, scientists, and parents do to address this problem?

The literature identifies three principal factors that relate to the lack of female involvement in science classes: culture, attitude, and education (Kahle, 1983; Jones and Wheatly, 1988). This paper reviews these factors and provides examples of programs that Pacific Northwest Laboratory (PNL)[a] and others have developed to increase the number of young women entering college ready and wanting to pursue a career in a scientific or technical field.

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Cultural Factors

Cultural factors that relate to young women's lack of participation in science fields include prevailing societal images of women, opportunities to participate in informal science activities, and parental involvement.

Culturally, stereotyping begins as early as kindergarten where perceptions of careers and occupations are formed (Vockell & Lobonc, 1981). The lack of female role models in science perpetuates the image of science as a masculine subject as early as elementary school. As students move into middle and high school they find that the majority of science teachers are men, and that textbooks, posters, and television all can perpetuate the belief that "science is for young men." For example, even today, many science programs on television have male leads (e.g., "Bill Nye the Science Guy," New Explorers, Nature, Newton's Apple, Beakman's World). Thus, young women get the message at an early age that scientific and technical fields are for men, and young men are being raised with the same stereotype.

To help change the stereotype of scientists and engineers at the middle school level, Pacific Northwest Laboratory's Science Education Center has used a before/after test called "Draw a Scientist" developed by Chambers (1983). The Laboratory used the activity as part of the OPTIONS program, an outreach program that helps selected Northwest middle schools build their capacity to deliver high-quality mathematics, science, and technology instruction to all students.

Here's how the "Draw a Scientist" activity worked. At the start of the program, we asked students in the four participating schools to draw a picture of what a scientist looks like and what do scientists do. Many of the drawings showed males with "Einstein-like" hair, white laboratory coats, and pocket protectors peering into bubbling beakers. Figure 1 shows one example of these student drawings. As you can see, the students' view of a scientist was masculine and "nerdy."

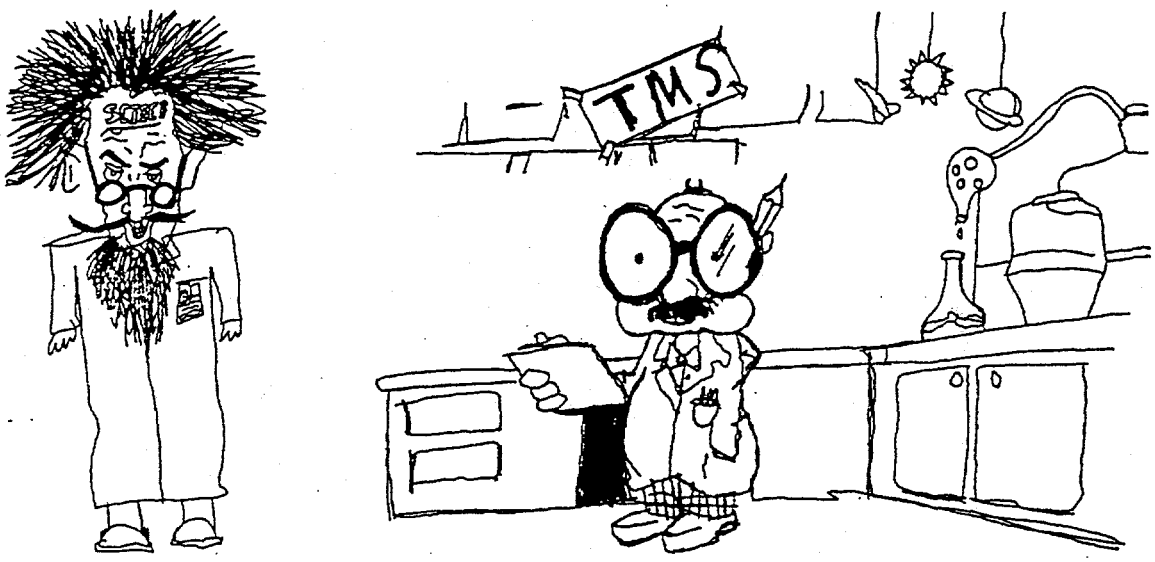

Figure 1. Student Drawings Before OPTIONS Day

We repeated the activity after more than 30 PNL scientists and engineers visited the school and interacted with all 6-8th-grade students through hands-on activities, demonstrations, and presentations. Figure 2 illustrates how "OPTIONS day" changed students' perceptions of how a scientist looked and what a scientist does. The drawings showed both men and women "doing" research, not only with beakers in a laboratory, but with rockets, plants and animals, and computers.

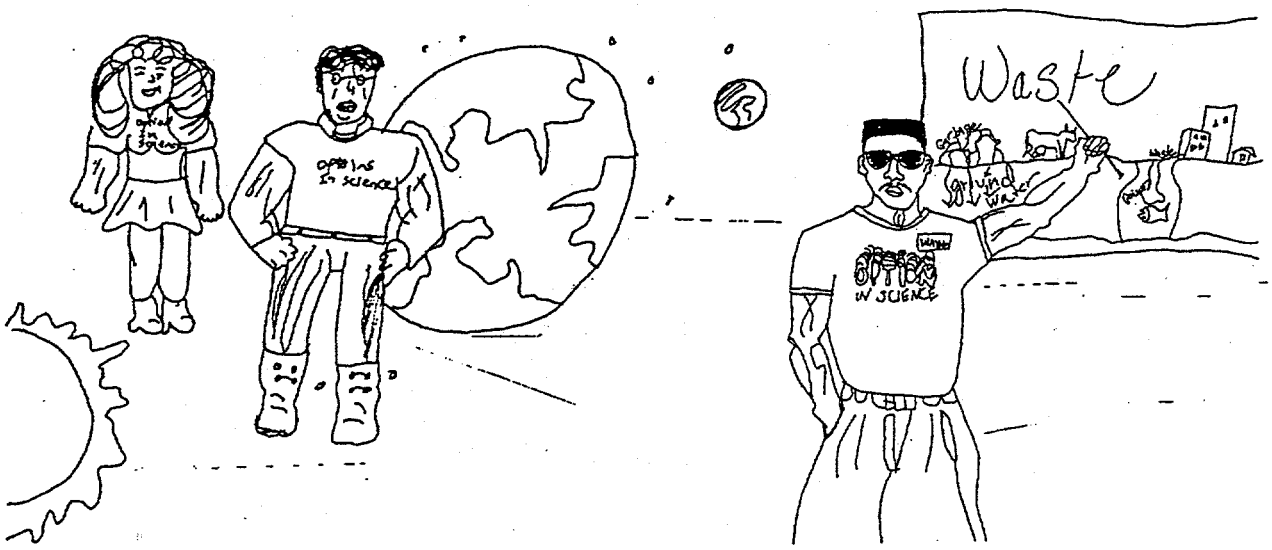

Figure 2. Student Drawings After OPTIONS Day

This simple activity showed the impact on middle school student's perceptions after just a brief intervention. School visits by role models, especially women in science careers, may positively affect both enrollment by young women in science courses and their personal consideration of a science career (Smith & Erb, 1989).

Another reason why so few young women pursue science studies is because they often have fewer opportunities to participate in informal (outside the traditional classroom) science-related activities. Examples of these activities include extracurricular activities—science projects and classes, experimenting with the family computer, and reading science-related books or articles that lead to a better understanding of science. We must make greater efforts to get young women involved in informal science where they feel comfortable "messing around" with science.

Well-designed science education programs encourage risk taking, provide hands-on, minds-on activities, foster creativity and problem solving and do not reinforce male and female stereotypes. Programs that offer such opportunities for young women include those sponsored by Girls Incorporated, local science museums, National Science Foundation-funded summer programs, and Family Science and Family Math programs. These programs all offer young women the opportunity to "do" science in supportive, informal situations.

Parental attitudes toward science also can affect how young women feel about science. Positive family attitudes and encouragement are important. Many young women do not receive the support they need at home to bolster themselves against a society that does not support young women achieving success in technical fields (Jones & Wheatly, 1988; Orenstein, 1994).

The PNL's Sharing Science with Families program is one way we have found to involve children and their parents together in hands-on, minds-on science activities. The evening classes taught by PNL researchers give parents and children a chance to learn about curtent

science and technology topics. The program provides families with an enjoyable science experience, relates learning science to real-world situations, and creates an opportunity for adults and children to be partners in learning.

Attitudinal Factors

Attitude is the second major factor that relates to why young women aren't involved in science classes. Attitude includes young women's lack of confidence in their abilities and the impact of relationships with other people. When young women are told they lack ability, they lose confidence in themselves and fail to achieve (AAUW, 1991; Orenstein, 1994). Young women do not want to fail. Because science and mathematics are often perceived as being difficult courses, many qualified young women choose not to enroll because they believe they will not get good grades.

The American Association of University Women (AAUW) study *Short Changing Girls, Shortchanging America* noted that when young men fail they blame it on outside circumstances: "the teacher didn't explain the problem; the teacher made the test too hard; or we didn't cover this material." When young women fail, they blame it on their lack of ability: "I didn't study hard enough; I didn't pay attention" (AAUW, 1991).

One way PNL assists young women to feel positive about themselves is by participating in the national "Take Our Daughters To Work" day, which was initiated by the Ms. Foundation in response to research on adolescent girls. Young women participating in PNL's "Take Our Daughters To Work" day spend time with their parents "on the job." They participate in laboratory tours and hands-on science and engineering demonstrations, and see first-hand the many career opportunities available to men and women.

Another attitudinal difference found in studies (Kelly, 1987) is the importance young women place on their relationships with people. Girls see mathematics, science, and technology classes as impersonal, dealing with data and facts that have no relationship

to their daily lives now or in the future. To address this problem, teachers need to show that science has a human dimension (Peltz, 1992) and is socially relevant.

Educational Factors

The ratio of young men versus young women in classes, especially, in high school can discourage young women from taking mathematics, science, and technology courses. Competition, comparison, and unease at being in the minority keeps many young women from continuing in upper-level science classes. In 1990, 21% of all high school students enrolled in physics; of this number, only 15% were female.

The expectations and behaviors of teachers and peers in the classroom also affect female achievement in mathematics, science, and technology. In many schools young women and young men interested in science are treated differently. Studies have shown that teachers pay more attention to young men than young women (Sadker, 1986, 1991; Orenstein, 1994). Young men generally are asked questions that demand higher level thinking or require them to expand on an answer. Young women are not called on as often and are rewarded for being neat, quiet, and good. In group activities, young men often "take over" the hands-on activities leaving the young women to be the data recorders. A study by Brown, Aldrich & Hall (Kahle, 1984) found that young women enrolled in mathematics, science, and technology classes were ambivalent, lacked encouragement, and received messages that what they were doing was inappropriate, impractical, or unacceptable.

Although young women spend a majority of their day interacting with teachers, most teachers are unaware of the subtle ways they unintentionally foster gender inequities as shown in the following example.

Read the following paragraph, and as you do imagine you are a 13- or 14-year-old young woman. Think how you would react to this situation.

You have enrolled in your high school's beginning computer-assisted design (CAD) class. You are excited about the class because you have used a computer at home, enjoy problem solving, and have been thinking about becoming a computer engineer after spending "Take Our Daughters to Work" day with a family friend, who is an engineer at a national research laboratory. On the first day, you walk into class and take a seat near the front of the room. As students arrive you realize you are the only girl in the class of 20 students.

While waiting for the teacher, Mr. Jones, to arrive you cannot help but overhear the young men talking about the hot dates they had over the weekend, cars, sports, and what a great basketball team Mr. Jones put together this year. The language and subject matter is making you more and more uncomfortable. Mr. Jones arrives, and you are surprised to find he joins right in with the young men and ignores you. Once class begins you realize that most of the students have had experience with CAD, and by the end of the first class you already feel behind.

If you were the student sitting in this classroom, how would you feel? If you were the teacher, what could you have done to make your only female student feel comfortable and welcome in the class?

We know that teachers are the key to successful intervention in the school setting. We need to train pre-service teachers (individuals training to be teachers at colleges and universities) and in-service teachers to be sensitive to the needs of all students. Successful teachers create classrooms that don't reinforce male/female stereotypes or use non-sexist language. These teachers confront bias in resources used in the classroom and connect science, mathematics, and technology to the real world.

One way PNL has helped educators address gender inequities is by actively participating on the Washington Science Teachers Association Equal Opportunities in Science Committee. The focus of the committee's work is to put current equity research into

practice. The committee serves as a network for educators to exchange ideas, and helps promote underrepresented groups' participation in science, mathematics, and technology. Committee members have organized three statewide conferences on Gender Equity in Science, and individual members have give presentations at state and regional science conferences. All teacher development programs at PNL include equity awareness training where we provide teachers with information to raise their awareness and provide ideas they can put to use in the classroom to help keep young women in mathematics, science, and technology classes.

Summary

In summary, to increase the number of young women entering college ready and interested in pursuing a career in a scientific field, we must advance with a three-pronged approach:

First, we must begin to change cultural factors that portray science, mathematics, and technology as masculine fields. Providing positive role models for young women, creating opportunities for them to participate in informal science, and encouraging family involvement in science experiences all would support young women's involvement in science.

Second, we need to create opportunities to help young women foster positive attitudes about their abilities and feel positive about themselves.

Third, we need to make teachers and students more aware of the expectations and subtle behaviors that affect female achievement in mathematics, science, and technology. We need to assist teachers in creating learning environments that encourage risk-taking, foster creativity and problem solving, and encourage high expectations for all students.

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