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WHY IS THIS TOPIC IMPORTANT?

Girls and boys start off equal in mathematics and science performance and interest in school. They appear to do equally well in both subjects in elementary school. Once courses become optional in secondary school, the down hill spiral in enrollment of female students in mathematics and physical science begins, accompanied by decreases in achievement and interest. This means that women are inadequately prepared for most college majors as well as those in technical fields.

Technology is becoming an increasingly important factor in the nation's economy, and participation and achievement in science is also becoming increasingly important. As a result of the decline in the birthrate since 1964, the size and composition of the population entering the workforce has changed. Women will represent 47 percent of the total workforce and half of those pursuing professional careers. Estimates from the U.S. Department of Labor indicate that women, minorities, and immigrants will make up 80 percent of the net additions to the labor force between 1987 and 2000 (Oakes, 1990:v).

WHAT DOES THE RESEARCH SAY?

"Lost Talent," recent publication written by Jeannie Oakes (1990), contains a review of current research on the relationship between educational practices and policies and low rates of participation of women, minorities, and disabled persons in science-related careers. Oakes has two central messages for her readers: (1) there is much we do not understand about the low participation rates of these groups, and (2) what we do know suggests that there are alterable features of schools that appear to constrain participation. Attainment in scientific fields is governed by three factors: (1) opportunities to learn science (and mathematics), (2) achievement in science (and mathematics), and (3) students' decisions to pursue science (or mathematics-related) careers. Unfortunately, there is little theoretical research on how these factors work together or the relative contribution of each factor to participation (1990:26).

WHERE ARE WOMEN LOST?

Gender differences do not appear at the elementary level in science. In middle school, girls hold more negative attitudes about science than do boys, and they report having fewer science experiences than boys. Students in grades 7 and 11 were asked, as part of the National Assessment of Educational Progress (NAEP), how often they had tried

to fix something electrical, fix something mechanical, or figure out what was wrong with an unhealthy plant or animal. Female students in grade 7 were three times more likely than males to report that they had never fixed something electrical or mechanical; in grade 11, the differences were even greater. Ninty-three percent of 11th grade males but only 66 percent of 11th grade females reported having tried to "fix something electrical" at least once. Sex differences were reversed for the unhealthy plant or animal question, with female students significantly more likely than males to have tried to determine what was wrong with an unhealthy plant (Weiss, 1989: Attitude Graph 11). Experiences students have had are closely linked to their interests.
In senior high school, relatively equal numbers of boys and girls enroll in academic and nonacademic curricula; therefore, similar science courses are available to them. However, girls choose to take these courses at lower rates than boys (Oakes, 1990:18). Armstrong found that motivation to enroll differed among males and females. For males, parental expectations for scientific and technical careers for their sons are the motivating forces while, for females, their own education aspirations provided the drive to enroll. So, women have to be more self-motivated to choose these courses (Armstrong in Tsuji and Ziegler, 1990:l).

Studies of junior high school students have shown that both sexes are unaware of career options and the educational requirements involved. If male students take courses due to parental pressure, they have still made the "right" choices. Female students, who need intrinsic reasons, would be less likely to have adequate information to guide their course-taking. Therefore, educators need to stress the relevance of mathematics to students' career goals. If this is not done, high school girls tend to avoid taking the advanced mathematics necessary for careers in science and engineering (Tsuji and Ziegler, 1990:1).

WHAT CAN BE DONE TO IMPROVE THE SITUATION?

Intervention programs are needed. Intervention strategies vary. They may be designed to appeal to students at one or more levels: cognitive, affective, and ability or achievement. Those at the cognitive level are designed to provide information, to increase awareness; while interventions at the affective level may be focused on increasing self-confidence or relieving anxiety. Those at the ability or achievement level are designed to result in increased ability, leading to improved achievement. Interventions aimed at affective or achievement levels appear to have more impact on behavior than do those aimed at the cognitive level (Tsuji and Ziegler, 1990:1).
When interventions are attempted, a range of possibilities for careers should be included. Careers in medicine, science, and engineering should be discussed, but so should careers in skilled trades and technological industries (1990:2).

WHAT KINDS OF INTERVENTIONS ARE

POSSIBLE?

Several kinds of intervention programs exist. These programs, as well as methods for evaluating their effectiveness, are discussed by Davis and Humphreys in their book, "Evaluating Intervention Programs, Applications from Women's Programs in Math and Science" (1985). Davis and Humphreys group intervention programs into five types: short-term, audiovisual and printed products, experiential learning, long-term, and teacher education.
Short-term programs serve to raise awareness and change attitudes. They may consist of a speakers series, one-day conferences, or workshops.

Audiovisual and printed products are used as interventions to raise awareness, change attitudes, or increase knowledge. Films, filmstrips, videotapes, books, puzzles, exhibits, videodiscs, and career posters may be used to provide information about science careers in a concise manner.

Experiential learning is used to give participants a hands-on experience in science or a science-related field.

Long term interventions consist of courses and curricula. They are designed to increase learning as well as to change attitudes.

Teacher education intervention programs may consist of summer institutes or inservice programs. Their purpose is to modify teachers' behaviors and improve their skills so that, ultimately, the learning and attitudes of their students are improved (Davis and Humphreys, 1985: 115-121).

HOW DO INTERVENTION PROGRAMS FIT INTO THE EDUCATIONAL REFORM

MOVEMENT IN SCIENCE EDUCATION?Persons interested in reforming science education are advocating measures that Oakes considers beneficial to all students - therefore, such moves should help increase the number of women considering science-related careers. Reformers advocate the abolition of tracking because track placements in curriculum tend to be fixed and long-term. Although tracking may be done to accommodate differences in student ability, it exacerbates differences among students by limiting opportunities to learn. Lower-track science courses may actually limit students' opportunities to learn the subject because of restricted content and diminished outcomes. Reformers are urging that science curricula focus on personal needs, create career awareness, and include the study of science-technology-society in terms of problems and issues found in the community or discussed through the media. Reformers also advocate that more hands-on activities be used in science, preferably in a cooperative learning situation. Girls benefit from such instructional tactics. If, as some

research data imply, current teaching strategies have led to early gender differences in attitudes, which then lead to differences in participation, changing teaching methods as well as revising the curriculum should help to decrease this trend.

Klein (1990) has identified 10 "common ground science process goals" addressed in current science education reform reports: enabling all to experience success in science; making the total science curriculum more unified and flexible; establishing requirements and procedures so that students will take more mathematics, science and technology courses; making science curricula personally meaningful; ensuring that tests and assessment procedures are unbiased and supportive of meaningful science instruction; using heterogeneous and cooperative groups to promote a high level of participation for all students; arranging for meaningful science role models; supporting enriching science education opportunities rather than ineffective remedial science education programs; increasing cultural sensitivity in instructional materials and classroom interactions; and increasing support for science achievement from parents, peers and the community (1990:5-11). Such goals, Klein believes, will work toward equity as well as educational reform.

WHAT ARE SOME RESOURCES FOR THE IDENTIFICATION OF

INTERVENTION PROGRAMS?"Equity and Excellence: Compatible Goals" (Malcolm, 1984) contains a listing of over 300 intervention programs. Rather than attempting to single out several of these programs for inclusion here, it is preferable that ERIC users decide for themselves what best suits their needs.

Most professional science and engineering societies have career brochures. Many are targeted at women and minorities. A listing of such brochures may be obtained by writing the Office of Opportunities in Science, AAAS, 1333 H Street, NW, Washington, DC 20005.

Also there are several national networks of women in science and engineering. These include:

American Association for the Advancement of Science

Education and Human Resources

1333 H Street, NW

Washington, DC 20005

Telephone: (202) 326-6670

Association for Women in Science

2401 Virginia Avenue, NW, Suite 303

Washington, DC 20037

Telephone: (202) 833-1998

National Association of Biology Teachers

Section on the Role and Status of Women in Biology Education

April Gardner

Dept. of Biological Sciences

University of Northern Colorado

Greeley, CO 80631

Telephone: (303) 351-2644

Society of Women Engineers

United Engineering Center

345 East 47th Street

New York, NY 10017

Telephone: (212) 705-7855

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