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Research over the last decade has shown that males and females have different classroom experiences because they approach learning differently and because teachers tend to treat them differently. Achievement expectations for females in some subjects are usually lower, as they are for members of certain racial and ethnic groups and for poor students.

Traditionally, females have found advanced mathematics achievement elusive. Girls' mathematic achievement in the elementary grades is equal to boys' but decreases in the middle school (Callahan & Clements, 1984; Dossey et al., 1988). An analysis of math achievement of twelfth grade girls in 15 countries revealed that in all but three countries girls were less successful than boys (Hanna, Kundiger, & Larouche, 1990). That gender differences seem not to surface until age ten (Callahan & Clements, 1984; Dossey, Mulis, Lindquist, & Chambers, 1988) suggests that the decline of female achievement is the result of a strong pattern of socialization to mathematics success or failure rather than to gender differences in innate ability.

As girls progress through school, they are less likely to continue their math education, either taking more rudimentary courses or dropping the subject altogether (Pallas & Alexander, 1983).

This digest reviews common teaching practices and methods of communication in the classroom--known as discourse--to indicate the treatment of female students that inhibits their ability to successfully learn math. It also identifies some negative attitudes about female mathematics achievement held by teachers and parents that may deter girls from continuing their math education.

SOCIALIZATION ISSUES IN FEMALE MATHEMATICS ACHIEVEMENT

Why females lose interest in math is the result of a number of factors, among them a decline in self-esteem and capitulation to the forces of socialization that encourage girls to focus on their bodies at the expense of a whole-person or achievement orientation. Historically, the adage, "math is not for girls," and the belief that girls should not reveal their intelligence lest it compromise their sexual desirability (and, thus, their social role as wife/mother), have combined to squelch girls' interest in advanced mathematics. Moreover, girls often are not given information about career possibilities requiring competence in advanced mathematics. Neither are they introduced to women role models with successful math careers, although, in general, role models can be an important factor in elevating a young person's aspirations.

At home, parents may unconsciously fail to provide support for their daughters' interest

in math, either by directing their interests elsewhere or by giving all their support for education to their sons. The attitudes of teachers and male students usually reinforce parents' message.

GENDER DIFFERENCES IN LEARNING STYLES

Evidence exists that males and females tend to approach learning from a different perspective, although the reasons for the differences continue to be debated.
In the classroom, females prefer to use a conversational style that fosters group consensus and builds ideas on top of each other; the interrelationship of thoughts and actions is paramount. Males, conversely, learn through argument and individual activity--behaviors fostered early. Most classroom discourse is organized to accommodate male learning patterns (Ong, 1981).

In addition, females are not likely to believe that math has utility in their lives (Fennema & Sherman, 1978); they see math as unconnected to a relationship model of thinking. Even if they persist in taking math courses, girls are apt to find that they don't like them, and liking a subject is key to succeeding at it (Lockhead, Thorpe, Brooks-Gunn, Casserly, & McAloon, 1985).

TRADITIONAL TEACHING METHODS AND CURRICULA

The classroom structure, designed to foster independent non-collaborative thinking, is most supportive of white male, middle-class socialization models, and it continues through university (Pearson & West, 1991). It encourages sex-role stereotyped forms of communication--independence, dominance, assumption of leadership--in which males have been trained to excel. Women, conversely, feel uncomfortable and excluded in situations requiring such behavior; yet, their participation--as questioners as well as newly-minted authorities--may be critical to knowledge acquisition and school success. The importance that women place on mutual support, building collaborative knowledge, and applying it practically is devalued in comparison with the importance of individual expertise to males and their inclination to debate abstract concepts.
Math curricula often exploit the differences between males and females by drawing on their different early play experiences. Action toys for boys teach core mathematics concepts (velocity, angles, three-dimensional configurations), while girls usually experience these concepts for the first time in a classroom.

THE ROLE OF TEACHERS IN LEARNING

In a classroom, teachers set the standard for discourse. Their reliance on teaching methods that adhere to traditional norms and beliefs about gender differences, and that

benefit only male students, can create a "chilly climate" for girls (Sandler, 1982; Kramaerae & Treichler, 1990).
Teachers, believing that participation is an indicator of learning, are likely to ignore females because they participate less than males. Moreover, teachers are often unaware that they are concentrating on teaching males because the process of classroom interaction is unconscious, and they respond automatically to student demands for attention. Males demand more attention, complain more that they are not receiving enough, and their teachers and female peers expect them to get it. Analyses of classroom discussions involving children between the ages of 9 and 11 in different settings revealed that boys took three times as many turns speaking (Redpath & Claire, 1989), and a study of college-age students demonstrated that men dominate discussions even more as they get older, in some classes speaking as much as 12 times longer than women (Krupnick, 1985).

Even when females do participate in classroom talk, their approach may suggest to teachers they have less command over the subject matter than males. Girls are more likely to ask questions, acknowledge the comments of previous speakers, and refrain from interrupting exchanges in progress. In other words, their classroom conduct is consonant with accepted sex-role behavior that compromises women's assertiveness (Hendrick & Strange, 1989). In comparing the participation patterns of males and females, teachers are apt to treat females' discourse contributions with less respect because girls exhibit less authority. In allowing classroom discourse to parallel sex-role differences in society, teachers unconsciously pass on negative expectations for girls.

RECOMMENDATIONS FOR ENCOURAGING MATHEMATICS ACHIEVEMENT

Since a goal of "Education 2000: An Education Strategy" is to promote students' science and mathematics achievement, and since sex equity in general is a societal goal, it is crucial to remove the barriers that prevent females from learning advanced mathematics.
A first step is an ATTITUDE CHANGE. If parents believe that their daughters can succeed in math and master technology, they will provide them with toys that promote math learning readiness and will encourage them to sustain their perseverance in math courses. If teachers understand and respect female learning styles, they will alter classroom discourse to accommodate girls' participation and provide a message to both males and females that no single learning behavior is superior to another.

Equally important are concrete CHANGES IN TEACHING METHODS AND CURRICULA. Cooperative learning that promotes collegiality between male and female students is one approach. Structuring lessons around the thinking processes needed to arrive at answers to questions rather than focusing solely on the answer itself is another. Math problems can reflect girls' experience (although they should not be limited

to stereotypically female concerns, such as cooking and sewing) and can emphasize practical, real life applications.

PROVIDING OPPORTUNITIES FOR GIRLS TO INTERACT AS PEERS,

separate from the co-ed classroom, can also strengthen their interest and participation in math as well as other school subjects.

Finally, GENDER BIAS IN EDUCATION AND CAREER COUNSELING SHOULD BE ELIMINATED. Only when females are convinced that they can both learn advanced mathematics and use it for professional success will full integration of math classrooms occur.

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