

Sex Equity in the Schools: The Role of Research

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Paper presented at the annual meetings of the American Educational  
Research Association, San Francisco, 1986.

Sex inequity in math and science continues to be a significant educational problem. Although women made up about 45% of the professional work force in the United States in 1983, they made up only about 13% of the science and engineering work force. Women were most under-represented in engineering and the physical sciences, more numerous in the biological sciences, and best represented in the behavioral sciences (NSF, 1984). Minority women are even less likely than majority women to be employed in math and science occupations; Cora Marrett's paper in this symposium discusses the special problems experienced by different minority groups in math and science. One reason for these differences may be that majority and minority women are less likely than males to take advanced math and science courses which allow entry into those fields. In this paper, we discuss research assessing why girls continue to be under represented in math and science careers, and examine the intervention programs that are attempting to facilitate girls' continued participation in math and science courses. In addition, we propose ways in which researchers and policy makers can better work together to develop, implement, and evaluate new intervention programs to deal with this problem.

Though sex inequity in math and science continues to be a problem, over the last ten to fifteen years progress has been made toward alleviating the problem. A great deal of research has been conducted that has helped identify why girls take fewer math courses. In addition, many changes have occurred in educational policy and in school programs. For example, federal laws such as Title IX have provided the legal basis for dealing with sex inequity. There have been changes in instructional materials and school curricula to eliminate sex and race bias. Educators now have greater awareness of the problems of sex and race bias and there have been some increases in participation by girls in advanced science and math courses, and in related careers. In the last 15 years, the proportion of women earning doctorates in science and engineering rose from 7% in 1965 to 25% in 1980. However, according to the National Research Council, most of the increase has come in the social and life sciences. Women still earn only 12% or fewer of the doctorates in math, physical science, and engineering.

In general, these changes mean that the manifestations of sex discrimination in school are now more subtle. Girls are now welcome in shop classes, advanced math classes, and physical science classes, although they may not be actively recruited. There are more athletic programs for women, and more coeducational physical education classes. However, though some of the overt barriers have disappeared, boys and girls still have different experiences in math and science classrooms. This means that research has to become more refined in looking at what goes on in these classes and interventions need to be better targeted if more progress is to be made. We turn next to a brief review of research bearing on the issue of why majority and minority females still are under-represented in advanced math courses. More complete reviews can be found in Eccles (1984), Eccles and Hoffman (1985), Linn and Peterson (1985), and Stage, Kreinberg, Eccles, and Becker (1985).

## Review of the Research

In this review, we would like to establish several key points. First, despite some claims to the contrary, it is important to reiterate that sex differences in math aptitude are slight (or nonexistent) in comparison to the sex differences in course participation and career choices (see recent volume edited by Chipman, Brush, & Wilson, 1985). Linn and Peterson (1985), in their review of gender differences in cognitive skills, concluded that gender accounts for only 1 to 5% of the variance in verbal and spatial skills (see also Stage et al., 1985). Such small differences should not produce the much larger differences in course enrollments and career choices that are found in American schools. Understanding the differences in how boys and girls are socialized remains the key to understanding the gender differences in math and science courses.

Research on socialization in the home and school has identified many important factors that could contribute to the differences in course enrollment. In the home, critical factors include identification with the same sex parent; the pattern of rewards and punishments for independent behavior and achievement behavior, with boys receiving more rewards for such behavior; fathers' greater involvement in math activities; and parents' stronger encouragement and higher expectancies for their sons in mathematics (see Eccles & Hoffman, 1985; Stage et al., 1985). The paper by Yee, Jacobs and Goldsmith in this symposium provides a closer look at research on these issues.

Recent work on socialization in the school has focused on teacher - student interaction patterns and how boys and girls are treated differently in math and science classes. In many math and science classrooms boys receive more instructional time and encouragement from teachers, and high ability boys get more praise and interact more with math teachers than do high ability girls (Becker, 1981; Leinhardt, Seewald, & Engle, 1979; Parsons, Kaczala, & Meece, 1982). However, it should be noted that such differences are found in only one third to one half of all classrooms. As discussed by Fennema in this symposium, boys also may learn to be more independent and to develop more complex cognitive strategies for dealing with mathematics. Fennema's paper in this symposium discusses this possibility. It seems that certain classroom structures and organizational styles facilitate girls' performance in math; the paper by Eccles, Mac Iver and Lange in this symposium discusses such "girl friendly" classrooms. Other work has shown that girls may need to receive active encouragement from teachers if they are to continue in math (Casserly, 1975). Still other work has examined how instructional materials influence children's learning and how sexist materials can lead to biases in children's attitudes (Scott & Schau, 1985). The instructional materials used in classrooms have changed some, but not enough. Finally, counseling in many schools remains inadequate, with too much emphasis placed on directing boys and girls to traditional careers. We believe that the school practices just discussed perpetuate existing sex differences (at best) and often increase them, rather than promoting equity. We will return to these research findings as we discuss the different levels at which intervention programs are implemented.

## Targeting Interventions at Appropriate Policy Levels

The term "educational policy" is often used as if it referred to one identifiable set of mandates created at one specific level of government. In thinking about policies for sex equity, the ones that immediately come to mind are at the federal level. These include Title IX, Title IV of the Civil Rights Act of 1964, and the Vocation Education Act of 1963. Title IX is the major federal law prohibiting sex discrimination in education and Title IV prohibits discrimination in education on the basis of race, national origin, or sex. The VEA focuses on equity in vocational education. Research suggests that these federal policies have been moderately successful, particularly in areas of physical education and vocational education. However, female enrollment in upper division math, science, and computer courses has not been affected enough.

Although the policies made at the federal level have been important policies made at regional, state, and local levels may be just as critical or more critical for effecting change. Due to the diversity of the forms educational policies may take, we need to be careful to use research to suggest policy changes at appropriate levels, and to evaluate which levels of intervention may be most appropriate. In this section we discuss the kinds of intervention programs that have been conducted at different policy levels and discuss where research findings have already been applied and how they might be used most fruitfully in the future.

Regional level. The coordination of technical services and the enforcement of Title IX and Title IV of the Civil Rights Act has occurred at the regional level. Sex Desegregation Centers have been established around the country to provide these services, resulting in regional variations in the content and administration of those programs. Though different regions often do have different problems and needs, perhaps more coordination of the administration of the programs would make them more effective. Further, the relationships between federal, regional and state levels are loosely organized, with little accountability, different goals, and frequent changes. Because we have a body of research on gender differences in math and science and are beginning to know what kinds of equity intervention programs work well, it would be helpful to have some coordination of efforts across regions so that everyone receives the same information and efforts are not duplicated. In addition, more cooperation and collaboration between equity specialists (e.g., race and sex equity) would be helpful, particularly because race and sex equity programs often are housed at the same site.

A major task of many of the regional Sex Desegregation Centers is to provide technical assistance to school districts. An example of this is the Planned Change Model, used at the Michigan Center for Sex Equity in the Schools (Linn, 1984). This model emphasizes making districts aware of the need to change, identifying problems within the district, developing an action plan, implementing the plan, and evaluating the success of the changes. To aid these efforts, research findings could be summarized, practical applications emphasized and made available to program planners, and workshops given to increase awareness about sex equity and disperse information about

new research findings.

State level. States vary dramatically in their commitment to sex equity. Some states have their own equity laws that go beyond Title IX, whereas others do not. There are different funding levels, and number of person hours committed to equity-related problems. However, little information is available on the amount of money spent or the types of services provided by each state. This information would be helpful in identifying which programs seem most effective, so that different states could provide similar services. The state level is a good one at which to apply research findings because many decisions about course requirements, testing, and teacher requirements are made at this level. Each of these areas has accrued a large body of research which may be used to inform policy decisions at this level.

A place to begin might be an examination of course requirements. The research concerning differences between males and females in mathematics and science course-taking shows mixed results. Some national enrollment data show equivalent enrollments in high school mathematics courses for females and males except at the highest level of calculus (Armstrong, 1980). Others find females taking slightly fewer math and science courses. 33.3 % of males and 27.7 % of females graduating in 1982 took at least 3 years of science, 47.5 % of males and 45.0 % of females took at least 3 years of math, but the females clearly concentrated in the life sciences, while males took both life and physical sciences. Certain minority females are under-represented in all upper division math and science classes (U.S. Department of Education, 1984). Though few states keep detailed course enrollment figures, and these are seldom broken down by class type, some investigations from different states have yielded sex differences in course-taking at the intermediate levels. In California, females are less likely to take Algebra II than are males (California Basic Educational Data System, 1981) and in Michigan, by eleventh grade only 51% of females are enrolled in math compared to 61% of males (Giese, 1980). Based on these findings, one strategy that could be used at the state level would be to increase the course requirements for math, science, and computers at the high school level so females are not selecting themselves out of these courses too early. This would also take the burden off of parents to push their children and off of females to be unfeminine by choosing certain courses. Similarly, the age at which students can drop out of school could be increased to keep minority youth in school and eligible for advanced math and science courses. If states became more systematic about obtaining course enrollment data, they could better chart their own progress in attaining equity, and target interventions toward the areas that have the most unequal enrollment patterns.

A second area in which much research exists is bias in testing. Much of this research has focused on race and ethnic bias, but some work is beginning to be done on the effects of particular kinds of test items on females' test performance (Donlon, Ekstrom & Lockheed, 1979; McCarthy, 1975; see Diamond & Tittle, 1985, for a review). The bias in testing manifests itself as test content that reflects the experiences of traditional male roles. Most states now have their own state-wide testing programs, which are often linked to graduation. Officials designing or selecting tests to be used in different

state-wide testing programs should be made aware of the problem of sex bias in test construction, so that they can choose tests that are more fair.

State laws also determine the licensing of teachers. Findings reviewed earlier show that boys and girls often receive differential treatment from math and science teachers, and that teachers often are unaware of this bias in their behavior. These findings suggest that one strategy at the state policy level would be to require a course in sex and race equity as part of teacher preparation. Teachers could be made aware of the potential for bias in the classroom and the need to give extra encouragement to children interested in non-traditional areas of study. In addition, guidelines could be developed for the incorporation of this information into other teacher training courses.

There have been a variety of good intervention models developed at the state level. For example, the California Coalition for Sex Equity in Education (CCSEE) was a coalition of the Sex Desegregation Assistance Center for Region IX, the California State Department of Education, the California School Boards Association, and the Association of California Administrators, funded by the Women's Educational Equity Act in 1978 (McDonald, 1981). They adopted a power-based model in which key decision makers and sex equity advocates were identified in 36 school districts as the major routes to gaining access to classrooms and effecting change. An evaluation of the effectiveness of this model indicates that it was reasonably successful in attaining its goals, though the program appeared to be more successful in some districts than others and was not successful in the area of non-academic activities (see Schmuck et al., 1985). A second example of a state-level intervention model is the On Site Long Range Planning Model (OSP) used by the Michigan Office of Sex Equity. This model includes an initial site visit to evaluate the problems within a district; recruitment of teachers, parents, students, and administrators to work as a team to set goals and choose implementation strategies for the district; technical assistance in carrying out the chosen goals; and a re-evaluation site visit at the conclusion of the implementation period. In both of these examples, one of the major components of the model is to get people at the district level involved in planning and implementing change strategies so that gains will continue to be made after the state-level support is withdrawn.

School district level. Many different sex equity programs have been tried at this level, and we will review some of the most effective ones here. One successful strategy has been the power-based strategy emphasizing the involvement of key decision makers in the district, which was used by CCSEE and was described in the earlier section on state level programs. The major advantages of this approach are that it puts responsibility on key decision-makers within the community rather than on an outside agent and that many issues can be worked on at the same time, because people at different levels within the structure may be involved.

A second strategy is hiring and promoting females and minorities within the district. This is an important strategy for two reasons. First, females and minorities in high positions may be more sensitive to equity issues and may keep them as primary objectives in everyday decisions. Second, there is a

need to have female and minority role models in positions of power. Role models are also needed as math, science, and computer teachers. Studies have found that advanced math courses are more likely to be taught by men (Fox, 1977) and some intervention programs designed to increase female participation through exposure to female role models have been successful (Brody & Fox, 1980; Tobin & Fox, 1980). The priorities within the district could be to hire females and minorities to teach math and science classes in order to provide good role models.

A final strategy that has been frequently used is to provide technical assistance to schools. This is usually in the form of textbooks and other curriculum materials to be used in the classroom, some type of in-service training for teachers, or by making resource people available. Each of these "assistance" strategies is mentioned below.

Research has shown that exposure to sex biased materials increases sex-typed attitudes, particularly when students are still developing their ideas about sex roles, as in the early elementary grades (Scott & Schau, 1985). Districts may check textbooks and library books for bias and actively seek sex-fair portrayals of women in careers requiring math & science, making sure that both girls and boys are pictured in book illustrations, bulletin board materials, and educational movies. Equity in math and science can be included as goals when making district-wide curriculum decisions, with specific behavioral objectives set for each grade level. Math and science coordinators at each school building can be provided with the information and resources to make sure that the equity goals are met.

Some districts provide in-service training for teachers based on the research about classroom interactions. These programs include methods to encourage students to continue in math courses and consciousness-raising about sex-fair practices in the classroom. One example of this kind of program is EQUALS. This program offers staff development for teachers, counselors, and administrators; provides materials to attract and retain students in math classes; models a variety of instructional techniques to improve student attitudes toward math; and increases awareness of career options and interest in math-related occupations (Kreinberg, 1981).

The availability of a Title IX coordinator as a resource person may also be made known so that teachers may go to that person with questions and complaints about bias. This strategy is not used in very many districts. Although a Title IX coordinator must be designated in each district by law, the information is not usually highly publicized, and the designated person often has many other duties. Most districts would benefit if they provided a job description, resources, and goals for the Title IX coordinator and then provided information to all teachers in the district about who the coordinator is and what the responsibilities are.

Classroom level. We do not generally think of changes at this level as "policy change" unless they are mandated at higher levels, but this is the level at which much of the recent research has been focused, and where the links between policy and research are most clear. Moreover, some have suggested that the "bottom up" approach of beginning with classrooms may be a

more cost-effective way of attaining equity than the "top down" approaches of mandating change from higher levels (Klein & Simonson, 1984). Existing and possible applications of some of the available research will be briefly reviewed.

Girls' interest in math be increased by exposure to female role models. Role models may include female math and science teachers, films & books about careers requiring math, contributions of females to science/math, or visitors from nontraditional occupations. Many programs have included a role-modeling component. A good example of this kind of program is the Career-Oriented Modules for Exploring Topics in Science (COMETS) at the University of Kansas (Smith, Molitor, Nelson, & Matthew, 1982). This program offers modules that are to be used by a role model, called a community resource person, to introduce her science career. The resource person can then go on to talk about her own interests, how she prepared for her career, and how it relates to other parts of her life.

Many of the programs concentrating on non-traditional occupations have been incorporated into counseling or vocational training. Although attitudes may be less stereotyped as a result of these programs, adolescents often hold unrealistic goals compared to their education and the kinds of work adults obtain. Fottler and Bain (1984) found that 56.2 % of high school seniors aspire to be in professional and technical occupations, although only 15.1 % of the U.S. labor force is actually in such occupations. Students may not be aware of prerequisites for particular careers. The importance of advanced math & science courses for the pursuit of many careers could be incorporated into career counseling and/or career information could be added to math/science classes.

Research on gender role development suggests that early adolescence may be a period of increased awareness of one's own gender role and a need to feel secure in that role (Hill & Lynch, 1983). Females enter puberty before males and may develop a heightened sense of wanting to conform to appropriate gender roles following this, due to the expectations of peers and other socializers. This may occur at the same time they are being asked to make choices between continuing in mathematics (a stereotypically male area) or a more female-typed area, such as English or the arts. In other words, course choices may be introduced at the wrong time for females, leading them to choose stereotypically female courses. One equity intervention might focus on finding a more developmentally appropriate time to introduce such course decisions.

Teachers sometimes use competition between boys and girls as a means of motivating and controlling the boys, and segregate boys and girls for many activities (Delamont, 1980). Both of these classroom management strategies reinforce traditional stereotypes and have not been found to be motivating to females. Lockheed and Harris suggest that the teacher needs to build equal status interaction into the structure of activities by using cooperative, mixed-sex groups. Intervention studies using these techniques have shown that they reduce sex stereotypes of the participants (Lockheed & Harris, 1978, 1982).



Information in math & science classes could be presented so that it is more appealing for females. By recognizing that some topics are more appealing to females and others to males and choosing topics that have some interest to both, teachers increase the likelihood that females will stay interested in the topic long enough to learn something about it. For example, the topic of light could be introduced by talking about the human eye or electricity by talking about record players. One intervention project in England has tried this approach with success (Girls Into Science and Technology - GIST; see Kelly, Whyte, & Smail, 1985).

As we discussed earlier, a large body of research indicates that the type and quality of interactions girls and boys have with their teachers in primary and secondary schools are different, and in many math and science classes boys tend to receive more favorable treatment. Based on this research, programs to change classroom interaction patterns and to increase teachers' awareness have been implemented. An example of this approach is the Teacher Expectations and Student Achievement (TESA) program in California.

Research suggests the importance of supportive mentors for females (Speizer, 1981; Tidball & Kistiakowsky, 1976). Based on this research, intervention programs have begun to use a mentor-model or nurture-groups to provide these supports. An example is the Academy in Mentoring at Eastern Michigan University (Van Voorhees, 1985). This program provides training in mentoring skills for junior high teachers and counselors who will serve as mentors for academically able girls. The activities are designed to provide teachers and counselors with information about how to provide support and encouragement to adolescent girls so that they will elect and be successful in courses in math, science, and technology.

#### The Role of the Researcher

The last issue we would like to address is how researchers can contribute more to educational policy. As the work reviewed earlier shows, research has made many contributions to policies concerning educational equity. A variety of research needs remain; including conducting better evaluations of the existing equity programs, examining teacher-child interaction patterns more closely; assessing peer and parent socialization influences on course choices and math performance. Another major need is the development of broader conceptual models about the nature of equity and how it should be studied. Harvey and Klein (1985) have developed one such model. Many recommendations for future research have been made, and the Klein (1985) Handbook for Achieving Sex Equity contains a particularly good summary of important recommendations.

Beyond doing more research, we believe researchers need to think more carefully about two other issues. First, there is a need to communicate research findings to policy makers in more effective ways. There are many ways this could be done. A few that we have come up with include: a) preparing clear, concise summaries of research results for dissemination to equity experts, program planners, and school district personnel; b) disseminating feedback to schools and teachers involved in research projects, and give in-service presentations in local school districts; c) writing short

summaries of findings for school newsletter or give presentations at P.T.O meetings; d) getting involved in planning state testing goals, course enrollment requirements, and textbook selection; e) consulting with textbook companies; and f) summarizing results to be used as press releases for the media by colleges or universities.

Another important thing for researchers to do is to make use of existing forums to reach policy makers. Several such forums are available. One place to find sex-affirmative materials and ideas for classrooms is the Women's Educational Equity Act Publishing Center at the Education Development Center in Newton, MA. A second forum is AERA's Editor-at-Large Program, involving a network of researchers and writers who prepare significant research findings for the popular press and non-research education publications. Beyond these outlets, there is a need for a clearing house for equity-relevant research reports, a place where short abstracts can be collected and disseminated to equity experts, program planners, and other policy makers. There also is a need to circulate a list of people and offices who would like to receive short summaries of current research among researchers in the field of sex equity. A chapter by Klein et al. (1985) has many more suggestions.

In addition to communicating research findings more effectively, we believe researchers and policy makers need to work more closely together, so that intervention programs to achieve equity can be designed and implemented more efficiently. More discussion between researchers and policy makers could lead researchers to assess issues that are more central to the concerns of policy makers, as well as to provide expertise in evaluating ongoing intervention projects. Such discussion also would give policy makers more direct access to research findings that they may need. More formal ties need to be developed, so that researchers, program planners, and other policy makers have opportunities to learn from each other and work together toward the common goal of more equitable educational policies.

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