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Gifted Females and Underachievement in Mathematics and Science Careers

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Abstract

A review of the literature showed that gifted females are underrepresented in the fields of mathematics and science. One major reason for few women in traditionally male careers is lack of participation in advanced mathematics and science courses. Internal causes of a lack of participation are ability, values, confidence, motivation, personality, and perceptions. External causes are stereotypes and parental support. Career choice is affected by tradition, marriage, and family. Attempts have been made to change attitudes and career aspirations, but more needs to be done in the areas of education, counseling, careers, and research.

Gifted Females and Underachievement in Mathematics and Science Careers

In recent years there has been interest in several special subgroups of the gifted population including the very young, the culturally different, the handicapped, and females. More needs to be done for all these special groups but the primary concern of this paper is gifted girls and women.

Callahan (1981) has stated that in spite of the approximately equal numbers of gifted female and male children, there is a predominance of gifted and creative males identified in the adult population. What happens to all the gifted girls? It seems that they do not reach their potential especially in the pursuit of mathematics and science-related careers.

This paper investigated reasons for the small numbers of women in these areas, the attempts which have been made to understand and improve the situation, and future directions which could correct the situation.

Research utilized the ERIC system and additional resources of the University of Northern Iowa library collection, curriculum laboratory, and faculty. The literature from these sources was synthesized and is reported relative to the stated problem.

Women in the Work Force

Women are underrepresented in scientific fields. Fox (1981) related that although women were 40% of the work force, they had only 1/3 of professional and managerial jobs and were underrepresented

in scientific and engineering fields. A 1980 study showed 1/10 of 1% of engineers in the United States and only 2% of the physicists were women (Rekdal, 1984). Data from the National Science Foundation (1985) indicate that women continue to be underrepresented although there has been growth. From 1976 to 1983 the employment of women increased 23% while the employment of women scientists and engineers grew 120%. Women were more likely to be scientists than engineers but only 15% of these women scientists had doctorates. Although most growth has been in computer specialties, there has actually been little change in the overall distribution of male and female jobs since 1976. The statistics show 12.7% of all employed scientists and engineers in 1983 were female. Table 1 indicates percents of women in various science and engineering careers (Statistical Abstracts, 1986). There were also small numbers of qualified females who were not in the labor force in 1983.

Mathematics and Science Participation

Different reasons have been offered for this underrepresentation in science fields. A major consideration in the pursuit of any career is the required educational preparation. "Many scientists agree that lack of math training acts as the 'critical filter' that bars many women from math/science occupations" (Lin, 1982, p. 18). Thus, much research has been conducted in the area of course selection. Rekdal (1984) cited a study by Sells in 1980 which found that 92% of entering women at Berkeley were not qualified to study 75% of the available majors. Similar situations have been reported elsewhere.

Table 1

Percents of Women in Science and Engineering Careers in 1983

Career	Percent
Engineer	3.3
Life scientist	21.8
Computer specialist	27.9
Physical scientist	9.8
Mathematical scientist	33.4
Environmental scientist	15.4
Social scientist	29.4
Psychologist	41.3

There have been, and still are, differences in the numbers of males and females participating in mathematics and science courses in high school and college. In the sixties the Project TALENT Women and Mathematics Study found that sex differences in mathematics achievement were highly predictive of sex differences in career outcomes (Wise, 1985). A survey of 13-year-olds and high school seniors in 1978 assessed factors contributing to mathematics participation. A complex situation was found though there were fewer male-female differences in participation than had existed in previous years. Some insignificant differences were found for higher level mathematics courses (Armstrong, 1985). Fennema and Carpenter

(1981) also reported that differences have diminished but some disparity still exists. DeBoer (1984) surveyed men and women college graduates about the science and mathematics courses which they had chosen in high school and college. He found that 90% of the women and 95% of the men had completed three years of high school mathematics. Although men enrolled for more courses in mathematics and science overall, the women earned higher grade averages. Kravetz (1984a) found that girls were taking more science and mathematics courses than previously and more women were majoring and earning degrees in those fields. The numbers, however, were not nearly proportionate to their representation in the general population.

At some point in the educational process girls are discouraged from pursuing mathematics and science. They excel in school in the elementary years but at the 6th or 7th grade level, the situation begins to change. Grades of female underachievers begin a downward trend in grade six and show a real decline by grade nine (Fitzpatrick, 1978). Several causes have been explored, both internal and external to the individual.

Internal Causes for Lack of Female Participation in Mathematics and Science

Innate Ability

Research has shown that "while sex-related differences in achievement are not always found, when they are found, they indicate that boys outachieve girls in high level cognitive tasks" (Fennema,

1984, p. 70). The Study of Mathematically Precocious Youth (SMPY) has examined thousands of students at the 7th and 8th grade level. With SMPY, researchers found that among students who scored 700 or above on the Scholastic Aptitude Test (SAT), boys outnumbered girls 13 to 1 and thus, concluded that a sex difference exists in mathematical reasoning (Kravitz, 1984b).

A study from Arizona State University was conducted in a summer program for 7th and 8th grade mathematically-gifted children. The results showed boys with higher ability in mathematical reasoning but there were no differences between males and females in spatial abilities, verbal reasoning, or personality factors. Mathematical reasoning was shown to be an important predictor of achievement (Weiner & Robinson, 1983). Fox (1977) has stated that men and women do not seem to differ in global intelligence but do differ in specific abilities. Sex differences in mathematical ability have appeared at the end of elementary school and men have exhibited definitely superior mathematical reasoning by the end of high school. Boys were found to be superior in spatial visualization areas. Armstrong (1985) reported males to be better problem solvers by the end of high school but found no sex differences in spatial visualization ability. A study by Eccles led to the conclusion that "our best measures of biological differences indicate a maximum of about a two percent variance in favor of males in mathematical ability" (Lin, 1982, p. 18). It can therefore be concluded that there is little agreement concerning the degree to which innate mathematical ability is related to sex

differences in mathematics achievement.

Confidence in Ability

Females have reported more anxiety and less confidence with mathematics (Fennema, 1980). Among the high scorers for SMPY's 1978 Talent Search it was found that "twice the percentage of girls than boys were uncertain or negative about their ability to handle more difficult math, and well over twice the percentage of girls than boys admitted to lacking confidence when it comes to mathematics" (Fox & Brody, 1979, p. 13).

A longitudinal study of 1500 children from 7th grade through high school of course selection showed that self-concept of capability influenced achievement as strongly as past performance. It was indicated that girls have a more negative self-concept, feel mathematics is difficult, and see little value in mathematics (Lin, 1982).

Casserly (1979) worked with gifted girls in Advanced Placement classes and found them to be modest and sensitive about high grades. They did not, however, show great confidence in their ability.

Armstrong (1985) found that confidence and low anxiety about mathematics was highly correlated with participation. Those students with confidence about mathematics tended to enroll for more mathematics in high school. These studies seem to indicate that lack of confidence in ability could be a major cause of the avoidance of such courses.

Attribution Theory

Attribution theory may offer some insights into the problem. Fennema (1984) stated, "Females' causal attribution patterns are different from those of males and causal attribution theory holds promise in helping understand sex-related differences in mathematics. Causal attribution has to do with what one believes causes successes and failures" (p. 72). She further stated that "success or failure occurs in mathematics because one is smart or dumb (ability), one tried or didn't try (effort), the mathematics one is doing is easy or difficult (task), or one has or doesn't have a good teacher (luck/environment)" (p. 72).

Studies have reported that males tend to attribute failure to external or unstable causes like luck, and success to internal causes like ability. Females tend to view the situation in reverse (Fennema, 1984). Females view success as due more to effort than ability. As courses become more difficult, females commonly perceive a need for greater effort and may lower their expectancies for success. This would seem to have an effect on females' motivation and persistence. Females might not be willing to take advanced courses and stick with difficult problems because of the way they feel about the reasons for success and failure.

Achievement Motivation

Theories of achievement motivation propose that humans naturally approach success and avoid failure. Callahan (1981) has said that women, especially gifted women, may develop a different motive, a

fear of success. They could fear social rejection or charges of unfemininity if they are too bright. "Especially in mixed-sex competition, females apparently sense a need to suppress their performance. Succeeding in the achievement domain may mean failure as a female" (Wolleat, 1979, p. 334). The conflict which could arise would adversely affect learning and creativity. To reach their potential females would need to resolve the conflict by gaining confidence and developing a strong internal locus of control.

Personality Traits

Other areas of research have been masculine and feminine traits. Instrumentality, self-assertiveness, rationality, and analytical thinking are typically thought to be masculine. Expressiveness and nurturance are considered feminine. A study by Hollinger (1983) divided 284 gifted sophomore females into groups according to the relative manifestations of these traits. Those who were categorized as androgynous (high in both types of traits) showed the highest social self-esteem of any group. Gifted females low in instrumentality had low self-esteem. This indicates the conflict over gender identity for these girls. Since the analytic trait is a characteristic of mathematically-able persons and also is considered masculine, females may tend to withdraw from typically masculine courses and careers because of this conflict.

Values

Fox (1976c) completed a study connected with the 1973 SMPY Talent Search of values of 7th graders compared to high school

students and also compared boys with girls. The gifted girls scored higher than the high school girls on social, theoretical, political, and aesthetic scales of the Allport-Vernon-Lindzey Study of Values. The gifted boys scored higher than high school boys on theoretical, social, and political scales. Gifted boys were the most theoretical of all the groups, strongly valuing mathematics and science. They were more precocious and did extremely well on the SAT-Mathematics Test compared to the gifted girls and normal high school students.

Perception of Career Usefulness

Fennema (1984) has found that as a group, secondary school females feel they will not use mathematics in their future. Mathematics is seen as inappropriate for girls so these young women feel anxious about success in mathematics with a corresponding negative attitude toward the subject. They feel that they must partially deny their femininity in order to achieve.

"Female students tend to avoid advanced courses in mathematics and science in high school, college, and graduate school because they perceive these areas as masculine or unrelated to their career goals" (Fox & Richmond, 1979, p. 257). This culture-based phenomenon could contribute to the small numbers of women selecting career fields in the areas of mathematics and science.

External Causes for Lack of Female Participation in Mathematics and Science

Stereotypes

How have the environment and society contributed to the situation?

Fox (1977) stated that educators believe that differential interest in mathematics and science comes from different childhood experiences and reinforcement of aspirations and interests which are associated with sex roles.

Sex-role stereotypes are conveyed in media, the home, and the schools. A study by Kirschenbaum (cited in Wells, 1985) found that by the preschool years, children know their sex and also what is expected of them in behavior, play, and psychological characteristics. Lin (1982) stated that most girls have been reared in a stereotypic fashion. Parents do not give mechanical toys to girls or involve them in activities required to maintain the family. Edwards (1985) cited Dr. Barbara Kerr who believed that female infants are handled more than males, that teachers call on boys more often and give more informative responses. Girls have been in classes ". . . where boys are encouraged and expected to succeed and where girls are tolerated if they are present" (Kravetz, 1984a, p. 4). Furthermore, Wolleat (1979) said that research has shown that teachers attribute the failure of girls to lack of ability and the failure of boys to lack of effort. Girls are likely aware of this and their belief in their own ability is affected.

Teachers and peers seem to have a negative view of girls who are gifted in mathematics. Studies have shown that teachers rate girls low who are analytic and unconventional in problem solving but reward boys with the same characteristics. A struggle develops early between unconventional interests and the natural desire for

acceptance. Passive, dependent females are rewarded by teachers while assertive, independent females are punished or ignored (Wells, 1985). Callahan (1981) said that " . . . it appears that many young girls and women have been enculturated to the extent that they fear that they will be rejected socially or be considered unfeminine if they appear to be too bright or too competent" (p. 502).

Gifted boys are not sure that women, in general, can equal men with respect to mathematics and think that females who do achieve in the field are few and atypical (Fox & Brody, 1979). Female mathematicians surveyed by Boswell (1985) said that the subject of mathematics is considered masculine. The women who pursue such a career are stereotyped as unattractive, unfeminine, cold, and distant. The stereotyped ideas are generally untrue but were first felt by these women from male peers in junior and senior high school.

The desire for acceptance by peers becomes very important through adolescence. The type of courses selected can be influenced by this desire. A study by Fitzpatrick (1978) of bright 10th grade females found the following:

> As girls pick up the notion that mathematics is a masculine area of expertise, those who are more subject to the influence of others perform less well in the mathematical area than do those who are less susceptible to the opinions of their peers. (p. 649)

Parental Support

Parents have contributed to the problem. An early interest in

mathematics was found to be more noticed and supported by parents of boys than parents of girls. Also, girls who showed mathematical interest were not given appropriate toys (Fox, 1977).

Not all parents act the same way. A study by Campbell and Connolly (1984) compared children of Asian parents with those of Caucasian parents. The results showed that although females in both groups had lower positive self-images than males, Asian females worked for technical literacy while Caucasian females worked for socialization. Parents of Asian girls were very supportive, held high expectations, and encouraged competition. Asian girls enrolled in more advanced mathematics and science courses and represented almost half of all Asian mathematics contest winners. Caucasian parents did not stress productive, technical careers equally for the sexes.

From parents and others, boys and girls learn different approaches to problem solving. Boys are taught to be thinkers, to take an analytic approach. Girls are taught to be "feelers" and have a global approach. Boys are taught to be assertive and exploring. Girls are overprotected and discouraged from independent problem solving (Callahan, 1981). Fennema (1984) stated that " . . . females, more than males, are not reaching one of the important goals of mathematics education, that of becoming thinkers who are independent problem solvers and who do well in high level cognitive tasks" (p. 74). Because of this, boys may slip more easily into the objective, impersonal mode and thus become more comfortable with mathematics.

Girls must fight natural preference and socialization to be comfortable in the thinking mode (Mills, 1984).

Parents exert the greatest influence on their children's values. What parents consider important becomes part of the children's value system. If parents discourage participation in mathematics and science by their daughters because they feel it is too difficult or inappropriate for their future, they will certainly have an effect on the number of mathematics and science courses taken. A survey by Armstrong and Price (1982) of high school seniors showed that the encouragement and expectations of both parents, along with the father as a role model, were important factors for student participation in mathematics. Boswell (1985) found that almost 20% of female mathematicians reported important encouragement by their parents to study mathematics.

Other Factors

There are differences between males and females in the amount of mathematics studied and their view of the importance of mathematics although gifted males and females were really more alike than they were different. They differed most in reasons for working and future expectations (Fox, 1979).

Fox (1976b) found that few girls studied mathematics independently or worked puzzles as often as boys. The motivation to study mathematics at leisure seemed related to values and career interests.

A study of mathematics majors by Maines (cited in Bright, 1983) found that males tended to have a focused view and females a diffused

view. That is, males concentrated their energy on a few mathematics related activities while females focused their energy on a wider range including social relationships, subjects, and careers. It has also been found that females are more reluctant to accelerate and do not like to compete with males in mixed-sex classes. The problem is even greater for Black and Hispanic females than for Asian and Caucasian females (Cook, 1981).

To summarize, it has been shown that females do enroll for fewer mathematics and science courses. This could be caused by innate ability, sex-role stereotypes, differential treatment by teachers, counselors, parents, or peers. Psychological variables such as attitude, motivation, confidence, and career aspirations also exert an influence. Researchers have reached no conclusions except that the problem is probably caused by a combination of factors.

The problem arises because the decision by females not to study mathematics is part of a circle reinforcing stereotypic behavior and keeping women from career equity. Girls do not take advanced, optional courses because of less self-confidence, less encouragement, and unclear career goals. If they do not complete the courses, their career options are limited and males continue to dominate (Fox, 1981). Rekdal (1984) stated that " . . . it is inordinately clear that women, in far greater numbers, have been and will continue to be restricted educationally and their career options radically circumscribed by inadequate math backgrounds" (p. 11).

In addition, Kravetz (1984b) said the following:

> The absence of women in mathematics courses from the earliest years when choice is possible results in the restriction of career opportunities, the loss of equity in opportunity to participate in the broadest spectrum of professional careers, and in a negation of potential for personal fulfillment. (p. 2)

Factors Influencing Career Choice

Ideal vs. Actual

So far it has been shown that one thing restricting women from mathematics and science careers is the lack of training at the secondary and college level. Perhaps there are other reasons why women seem to avoid traditionally male career fields.

One study (Wilson, 1982) of 55 gifted high school students in Southern California found that there were male-female differences in ideal and actual career choices. While 96% of males chose a traditionally male career, only 83% of the females chose the same types of careers. Both sexes chose mathematics and science-related fields but females chose areas such as accounting while males chose careers such as engineering and astronomy. Females who showed a difference between actual and ideal choice gave reasons such as lack of money or talent. Males were not so concerned with those reasons.

Tradition and Conflict

Society has always exerted a great influence on its members. Women have been socialized to be nurturing, to marry, and to have

children. Career interest is reported to peak for girls in the early adolescent years when the nurturant role begins to become more important. Many females thus have chosen a career which was considered consistent with the nurturing role (Wolleat, 1979).

Most women are expected to marry spouses at their own or a higher intellectual level. Gifted women thus have had fewer suitable choices available in the population. They have delayed starting a career and making decisions until appropriate mates were found (Khatena, 1982). Even when husbands were found, the women may have avoided conflict by choosing a career close to the traditional female role. They may have delayed their careers to avoid decisions of whose career should take precedence.

Then there was the question of motherhood. Some women tended to delay careers until their children were older, thus making their jobs more difficult after a long absence from the work force. Some women delayed motherhood until careers were established. Others tried to be all things to all people, juggling the roles of career woman, wife, and mother.

Women have been socialized to experience achievement vicariously through their husbands' or children's successes. Males, conversely, have achieved their status and reward in a direct way from their own careers (Wolleat, 1979). Status and reward for females came indirectly so when they desired personal achievement, they met with conflict (Khatena, 1982).

Wolleat (1979) has said the following:

> If a male achieves eminence as a scientist, scholar, physician, lawyer, or artist he has more than met the social expectations for his sex; whereas if a female achieves eminence in these same fields she may be viewed as having done so at the expense of meeting her appropriate sex-role expectations. (p. 333)

The degree of conflict has been shown to differ. Rodenstein and Glickauf-Hughes (1979) conducted a longitudinal study of gifted women in three groups: those who had a career of primary importance to them; those who were homemakers and thought children, close relationships, and social occupations were most important; and those who were integrators, choosing all types of careers along with family. Career women were those who chose investigative areas. Homemakers preferred social occupations, but integrators were found in all areas. Integrators were found to be most satisfied with all parts of their life but needed great mental strength and outside support in order to be part of this group.

Another consideration which influences women's career choices is financial compensation. Salaries for men and women in the same occupations have differed. Pogrebin (1981) found that although women had been entering nontraditional fields in ever greater numbers, they usually earned lower salaries than men in the same jobs. This was not found to be as true in the science and mathematics-related fields such as engineering and chemistry as in other careers.

Summary

Thus far it has been shown that girls and women have tended to take fewer mathematics and science courses in school because of parental, teacher, peer, and societal treatment and expectations. There also has seemed to be some relationship to the types of motivation, to self-image, to masculine-feminine traits, and possibly to differences in types of attitudes and interests.

The situation may be changing, especially for gifted girls. Fox (1981) found that for the 1978 SMPY Talent Search, 64% of boys and 73% of girls planned to study calculus. By studying advanced mathematics courses more options will be available.

It has also been shown that there are many pressures from tradition and society on women which affect career choice. Change will be a very slow process, but society needs the talent which gifted women offer.

Solving the Problem - Past Attempts

Some studies have been conducted to examine factors that could have a positive effect on the selection of mathematics courses by females and their pursuit of nontraditional mathematics and science-related careers. A survey by Armstrong (1985) found that the three variables affecting achievement and participation in mathematics were (1) positive attitude, (2) positive influence of significant others, and (3) perception that mathematics is needed and useful for careers.

Attitude

Several projects have attempted to improve attitudes toward mathematics. A program at the Pacific Science Center called Math for Gifted Girls was reported by Cook (1981). She found that because the mathematics avoidance syndrome begins in middle school years when mathematics is still required, and little attention had been paid to the emotional side of the issue, the program was helpful. Bright girls with low mathematics scores and their parents were involved. Problem solving, careers, spatial activities and computers were part of the short course which was taught by females. There was a big change in attitude and ability but not much change in the girls' confidence in their ability. Time was spent discussing feelings and fears and this probably had a positive effect.

The GATE Program at California State University, San Bernardino, offered summer classes to girls who were gifted and advanced by two years in their mathematics study. The class was taught by a female expert in mathematics, statistics, and computer science. The girls did hands-on work, asked questions, and defended their solutions. The program was very successful as enrichment and caused an attitude change toward mathematics, computers, and the desire for careers in those areas (Kravetz, 1984b). The classes, homogeneously grouped, did seem to improve girls' attitudes toward and achievement in mathematics.

Influence of Significant Others

The second variable, the influence of others, has also been

examined. A study by Stamp (1979), in English schools, found that girls seem to be open to persuasion at two stages:

> If more girls are to be encouraged to choose mathematics as a course of study to higher levels, it appears from this study that they would be susceptible to persuasion at two stages in their lives: in early years, when the attitudes which they form to different subjects are affected by their mothers' attitudes; and later, when they make choices of subjects, and they are influenced by people who appear influential, such as fathers and teachers. (p. 48)

Fox (1981) has stated that "career choices, particularly those in non-traditional careers, including math and science, appear to be influenced directly and indirectly by teachers" (p. 24). These findings have implications for schools.

Although acceleration for the highly gifted seems to be favored by educators, girls may actually go out of their way to avoid it. Callahan (1981) reported that at SMPY it was found that girls felt parents would not approve of acceleration and there would be peer rejection. There was also a fear of failure at new activities. A study by Lyons (1980) found that high school girls who would accelerate studies and thus take more mathematics were more likely to have fathers in mathematics-related occupations and mothers who were not employed or who worked later in the girls' lives. It was also found that parental reinforcement for achievement of accelerated girls had only a moderate influence. Rodenstein and Glickauf-Hughes (1979) found

that parents' occupations, encouragement, and influence showed little significance on female career choice.

Usefulness of Mathematics in Careers

Some gifted 7th graders from the 1973 SMPY Talent Search were examined for career interests. Gifted boys at that age seemed to have a stronger idea of career choice and chose traditionally masculine areas. Gifted girls were more open to interests in both masculine and feminine traditional careers but had stronger preferences for social and artistic areas. Gifted girls seemed to know that they had ability to pursue investigative careers like science and medicine so may have experienced more conflicts than most people in career choices (Fox, Pasternak, & Peiser, 1976).

Several other studies have investigated counseling. One project was a career awareness class for 7th grade girls in the summer of 1977, sponsored by the Intellectually Gifted Child Study Group at Johns Hopkins University. Instructors and guests gave indepth information on careers and practical applications to human problems. Along with this, critical reading and thinking skills were taught with courses on statistics, computers, aging, environment, and women in science (Fox, 1979).

Counseling sessions extending over a five week period with adolescent girls dealing with nontraditional careers and role models were reported by Brooks, Holahan, and Galligan (1985). They showed no significant effects on career preference and sex-typing of careers.

A one-day Guidance Laboratory for Gifted and Talented Students in 11th grade was held at the University of Nebraska with class visitations, individual and group counseling, and a group life-planning activity. The results showed that girls raised their career aspirations as a result of the program but boys did not (Kerr, 1983). From these attempts it can be seen that results have been mixed with some successes and some failures.

Acceleration of the gifted is favored by many educators in order to avoid boredom and reach career goals sooner. Results for gifted females have been mixed. At SMPY they found the regular accelerated program was too theoretical for the girls. They did not like the competitive atmosphere or the independent study of the class. They also did not feel that the accelerated program related to their career interests and goals. A special all-girl accelerated class was held during the summer and was taught by females. There was a more cooperative atmosphere with emphasis on social problems and career information. The program was successful with about half of the girls (Fox, 1976a).

A follow-up study (Fox, Benbow, & Perkins, 1983) of the girls from the special class compared to control groups found that the most successful girls in the class did eventually take more mathematics courses than the control groups. The researchers concluded that for the highly gifted student this type of intervention outside the regular school was very effective and necessary. For the less gifted, a flexible program in the school was sufficient. There seemed to

be no real disparity between boys and girls, except for calculus, in the continued education and career aspiration of these gifted young people. Girls did regard a lack of female role models as an obstacle to the selection of careers in mathematics and science.

Girls can be recruited into accelerated classes, including the Advanced Placement Program, if the classes are part of the regular school day and taught by women. There also must be a sufficient number of girls in the class (Fox, 1977).

Thus, there have been some attempts to increase the interest of gifted girls in traditionally-male careers including those related to mathematics and science. Also, some work has been done to encourage gifted girls to take more mathematics and science courses to keep their options open, but more needs to be done.

Future Directions

Education

In the area of teaching, Callahan (1981) has suggested that activities in visual-spatial problem solving be provided for females since this is one area where boys seem to have an edge. She has also suggested that there be activities to help girls develop an internal locus of control and to establish goals. Examples of, and interaction with female role models are other considerations which schools should implement.

Wiener and Robinson (1983) have contended that educators should pay more attention to cognitive styles to encourage females. They should use textbooks which explain all steps and concepts, provide

remediation for females to develop formal strategies, and find ways to utilize the strengths of all gifted children.

Wells (1985) has stated that, even at the pre-school level, materials should be screened for sexism. Field trips and creative dramatics should be used to eliminate stereotyped behavior. There must be better identification, more support, and higher expectations for females.

Dr. Barbara Kerr (cited in Edwards, 1985) has stated that at the pre-school level there must be nonsexist toys and clothing. At the primary level girls must be exposed to intellectual challenges, adventures, and careers. This should continue at the junior high level with female mentors, if possible, and strong encouragement to study mathematics. Senior high gifted girls need nonsexist career counseling, mentors, volunteer work, and a focus on education, not perfection. At all ages there must be freedom to follow talents wherever they may lead.

Counseling

One very weak area has been in counseling. Counselors in schools have often been overloaded and have had very little time to devote to the gifted. Many have passed on their own stereotypic views of female roles. Counseling " . . . must begin as early as elementary school, when attitudes and opinions are being formed and graduation requirements have not been fulfilled, but anticipated" (Rekdal, 1984, p. 12). Wolleat (1979) has said that males as well as females need to be counseled about stereotypic attitudes. There

should be individual and group counseling activities for gifted students to work on self-esteem, self-confidence, competitiveness, and assertiveness. There should be information about life-styles, careers, legal rights to opportunities in careers and scholarships, and the importance of taking advanced mathematics. Encouragement should be given at a young age to begin making plans for the future (Wolleat, 1979).

Researchers have noted several areas of importance for counselors. One is that of early identification. "For the intellectually gifted, early identification leading to academic acceleration may enhance rather than impede social development and mental health" (Fox & Richmond, 1979, p. 258). A counselor must reach both achieving and underachieving girls because of the conflicts which will affect all of them as they get older.

A second area is that of helping girls to deal with significant others. Callahan (1981) contended that the counselor should be prepared to advise parents of their roles in encouraging daughters to develop their talents. There will be negative pressures and influences from some teachers. The counselor needs to keep abreast of research and should support innovative academic programming for the gifted. Girls may have to be recruited for advanced mathematics and science classes. Teachers and counselors can work together. Gifted females must be made aware that mathematics is important for entry to many fields and that scholarships and grants are available. Girls who tend to be less sure of their ability need support and

encouragement from counselors and teachers (Wilson, 1982).

Gifted girls and women have wide choices but tend to limit themselves. Because of peer pressure, gifted females may hold back and experience conflicts. Fox and Richmond (1979) suggested the following:

> Counselors of gifted females would be wise to develop ongoing support groups in which young women can regularly meet and explore life roles that may be apparently conflicting, examine and clarify their values, engage in goal-setting activities, and learn conflict-resolution techniques. (p. 258)

The gifted are susceptible to the same pressures as less capable students and need as much or more guidance to set life goals and explore options.

Careers

Herr and Watanabe (1979) stated that all gifted children have career development problems with multipotentiality of career choice, pressure from expectations of others, views of careers as lifestyles and monetary investments, social isolation, and lack of adult role models. Girls encounter conflict because of society's expectations concerning choices between marital and occupational aspirations.

Because of their talents, many really do not need to choose between family and career. Zaffrann and Colangelo (1979) contended that they should be encouraged to train for careers which can begin after a family is reared. "Our society is greatly in need of the unused brainpower that is represented by bright girls. We can

no longer allow them to take menial and marginal part-time jobs as they get into their forties" (Zaffrann & Colangelo, 1979, p. 149).

Research

More research is suggested in several areas. Teachers would like to know when gender differences in mathematics reasoning ability occur and why. Research on the matching of particular teaching methods to type of reasoning ability may help the educator to adjust to differences (Weiner & Robinson, 1983). The conditions under which acceleration and/or enrichment should be used also need further investigation. Segregated classes have proven beneficial for girls but there are questions of necessity and legality. The issue of whether programs should be different for girls at different age levels has not been explored (Kravetz, 1984b).

Fox (1977) contended that there should be more research in the area of sex-role stereotypes, including role models, career counseling, and parent/teacher awareness. There should be studies examining homogeneous grouping according to abilities and interests. Attention to readiness is needed for content and transition from concrete to abstract with possible acceleration. Early identification and planning is important for girls and should be studied further. The gifted child, especially the gifted girl, because of our unnecessarily rigid system is " . . . discouraged from seeking intellectual challenge . . . " (Fox, 1977, p. 134).

Case studies of the mathematically gifted are needed to enable them to learn who they are, how they feel and learn, and who best

influences and helps them to reach their potential. Longitudinal naturalistic studies would be best (Fox, 1981).

Summary and Conclusion

Gifted girls and women are a segment of the population in need of attention. They should be encouraged and recognized by parents, teachers, counselors, and peers. They should be prized by society. Especially in the areas of mathematics and science they do not appear to be living up to their potential. There is disagreement about whether they have less ability, different ability, or just hidden ability.

Females probably do not have less general ability. If their abilities are different, researchers need to discover special attributes in order to enable society to utilize the talent wisely. The community will benefit from talents of all its citizens.

If ability is hidden it may be due to different achievement motivation, self-image, values, and interests. Conflicts arise over female roles in this society compared to talent and interests.

Research has been conducted and interventions have been attempted. Although there has been progress in the number of gifted girls pursuing careers in traditionally-male mathematics and science fields, there has not been a great change. Early intervention before stereotypic values and influences have time to affect career choice is important. Positive female role models and action by society to encourage a wider range of career choices for women would be beneficial.

The problem is complex and the solution is not simple. A solution is necessary, though, if the world is to stop the waste of half of the talent of the gifted population, the talent of gifted girls and women.

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