# 10

# An Accelerative Intervention Program for Mathematically Gifted Girls

Linda Brody and Lynn H. Fox

ABSTRACT

An intervention program designed to increase gifted girls' participation in mathematics was conducted at The Johns Hopkins University in the summer of 1973. The program consisted of a course in algebra I for twenty-six seventh-grade girls and included special attention to the social needs of the girls, female role models, some career awareness training, and an emphasis on the social applications of mathematics. Control groups of boys and girls who did not participate in the program were selected for purposes of comparison in assessing the program. In 1977, when the students had completed the eleventh grade, there were significant differences in mathematical acceleration between the control boys and the control girls and between the experimental girls and the control girls, but not between the experimental girls and the control boys. Differential values, career interests, and encouragement are explored as possible contributing factors to sex differences in course-taking behavior.

Sex differences in mathematics are most apparent in course-taking at the secondary and post-secondary levels and in the careers pursued. Fewer women than men pursue careers in mathematics and science, and girls are more reluctant than boys to take advanced mathematics courses. As Lucy Sells has shown, in chapter 5 of this volume, the level of high-school mathematics achievement acts as a "critical filter" for eligibility to a variety of college majors and careers. Since girls are less likely than boys to take advanced mathematics courses in high school, sex differences in mathematics at the college and career levels result.

There are two major hypotheses in the present study: First, gifted boys and girls from similar home backgrounds and of about equal ability in mathematics at grade seven will differ in the high-school years with respect to mathematics achievement as measured by the advanced mathematics courses taken. This difference will be a result of differential interests and encouragement. Second, girls who receive special encouragement and facilitation in mathematics in an accelerated algebra program will keep pace with or surpass their male and female cohorts with respect to achievement as measured by coursework. It is thus the premise of this paper that some type of intervention program in mathematics is necessary for gifted girls to ensure their persistence and success in advanced mathematics courses at the same rate as gifted boys. Because of internal and external barriers that discourage girls from achievement in mathematics, gifted girls need more encouragement than do gifted boys to pursue mathematics courses. In this study an attempt was made to influence later mathematics course-taking behavior of gifted girls by changing course-taking behavior in the eighth grade. A secondary consideration was to try to influence their attitudes and career interests in the hope that this too might affect later course-taking.

## THE INTERVENTION PROGRAM

An experimental mathematics program was conducted for mathematically gifted end-of-the-year seventh-grade girls at The Johns Hopkins University in the summer of 1973. The class met two days a week for about two hours from May through July and covered a standard algebra I curriculum. It was hoped that a positive experience in mathematics at the junior-high-school level, when mathematics was becoming more abstract, along with the opportunity to accelerate one year in mathematics, would increase the likelihood that the girls would take advanced mathematics courses in high school.

An experience with an accelerated mathematics class for both boys and girls in the summer of 1972 suggested that attention to the social interests of girls was necessary to attract girls to the program and to help ensure their success (Fox 1976*a*). Thus the class was designed to provide social stimulation in several ways: The class was for girls only. In order that the girls might have role models, the teacher was a woman, and she was assisted by two female undergraduate mathematics majors. The structure of the class was informal, instruction being individualized and in small groups. Cooperative activities rather than competitive ones were stressed. Whenever possible, the teachers emphasized the ways in which mathematics could be used to solve problems. Some traditional word problems were rewritten in an attempt to make them more socially appealing. In addition to the classes, there was a series of speakers, both male and female, who met with the girls to talk about their careers in mathematics and science.

Students were selected for the program on the basis of performance on the mathematics subtest of the Scholastic Aptitude Test (SAT-M) in either the mathematics or the verbal contests (conducted by the Study of Mathematically Precocious Youth [SMPY] and the Study of Verbally Gifted Youth [SVGY], respectively, at The Johns Hopkins University in the winter of 1973) and geographic considerations. Thirty-two seventh-grade girls living in the Greater Baltimore area who had scored at least 370 on the SAT-M as seventh graders were invited to take part in the class. Two additional girls were invited on the basis of referral and subsequent testing. Twenty-six girls enrolled in the course.

## *Assessing the Intervention Program*

The full impact of the intervention program cannot be assessed until 1983, the year that these students would be expected to complete a four-year bachelor's program. It is possible during the interim, however, to assess course-taking behavior in high school, as well as any changes in career goals since the intervention. In order to measure the effects of the intervention program, it was necessary to form control groups of equally gifted girls and boys so that course-taking behavior and career interests could be compared with what they presumably would have been without the intervention.

*Selection of the Control Groups.* Two control groups were formed, one of girls and one of boys. For each experimental girl who enrolled in the course, a control boy and a control girl were selected from among the other seventh-grade participants in the 1973 contests. The control students were matched with the experimental subjects on the basis of scores on the mathematical and verbal subtests of the SAT, education and occupation of father, and education of mother.

Although the matching was not perfect, the general pattern was to match within plus or minus twenty points on the SAT-M and the SAT-V while controling for the educational and occupational levels of parents. The mean scores for the experimental girls on the SAT-M and the SAT-V were 436 and 399, respectively. The mean scores for the control girls on the SAT-M and the SAT-V were 433 and 390, respectively, and the control boys, 443 and 393, respectively. The details for the matching variables for the three groups are reported elsewhere (Fox 1976*a*) and are summarized in table 10.1.

*Pretest measures.* Prior to the course, the experimental and control groups were tested on knowledge of algebra, values, and career interests. There were no significant differences in knowledge of algebra. Control boys did differ significantly from the experimental and control girls with respect to values and one measure of career interests: The control boys were more interested in investigative careers, which include mathematical

TABLE 10.1. Mean Scores on the SAT-M and the SAT-V and educational level of parents

| Group | N | Mean SAT-M | Mean SAT-V | Mean educational level[a] Mother | Mean educational level[a] Father |
|---|---|---|---|---|---|
| Experimental girls | 26 | 436 | 399 | 2.9 | 3.3 |
| Control girls | 26 | 433 | 390 | 2.9 | 3.7 |
| Control boys | 26 | 443 | 393 | 2.7 | 3.5 |

[a]Scale:
1 = less than high school
2 = high-school diploma
3 = some college
4 = bachelor's degree
5 = graduate study beyond the bachelor's degree

and scientific careers, and scored significantly higher on the theoretical scale of the Allport-Vernon-Lindzey Study of Values (SV). Thus, at the start of the program the boys and the girls were not very different with respect to achievement and aptitude in mathematics, but the boys were already slightly more predisposed toward the pursuit of mathematics in school and careers.

*Evaluating the program.* The program was evaluated following the completion of the course. Details of this evaluation are reported in another volume in this series (Fox 1976*a*). Of concern were (1) whether an emphasis upon social factors was effective in recruiting girls to participate in the program, (2) the degree to which the girls succeeded in mastering algebra I, and (3) whether the program resulted in the girls' accelerating themselves in mathematics in school the following year.

As mentioned above, of the thirty-four girls invited to participate in the class, twenty-six (76.5 percent) enrolled. This was considerably better than the enrollment rates of 58 percent and 26 percent, respectively, for the two summer, mixed-sex accelerated classes conducted by SMPY prior to the experimental girls' class (Fox 1974; George and Denham 1976). Thus, the emphasis on social factors was successful in recruiting girls for such an accelerated program.

The mathematics course for the experimental girls was not totally successful. Of the twenty-six girls who enrolled for the course, only eighteen actually attended the classes on a fairly regular basis and completed the course. The completion rate for the course was not significantly higher than the completion rate for girls in two other accelerated classes that were coeducational and taught by a male (see Fox 1974; and George and Denham 1976).

Of the eighteen girls who completed the course, only eleven actually enrolled in algebra II the following year. This was the result of several factors, mainly the reluctance of teachers or principals to allow the girls to study algebra II in the next school year.

*Follow-up assessments of course-taking.* Follow-up studies were conducted in 1974, 1975, 1976, and 1977 to assess course-taking behavior. Table 10.2 shows the number of students accelerated in mathematics at the time of each follow-up. Ten girls successfully completed algebra II and were accelerated one year at the end of the 1973-74 school year. None of the control boys and girls was accelerated at this time.

The 1975 follow-up study was conducted when the students had completed the ninth grade. At that time, twelve of the twenty-four experimental girls who responded (50 percent) had completed algebra I, algebra II, and plane geometry and thus were accelerated a full year in mathematics. Only four control girls out of twenty-five (16 percent) and five control boys out of twenty-five (20 percent) were accelerated. Thus two years following the intervention, considerably more experimental girls than either control boys or control girls were accelerated in mathematics as a result of the special class.

By the end of the 1975-76 school year (at the end of tenth grade), twelve out of twenty-five experimental girls (48 percent), two out of twenty-three control girls (9 percent), and eight out of twenty-six control boys (31 percent) were accelerated at least one full year in mathematics. Thus after three years, still more experimental girls than students in the control groups were accelerated in mathematics. The number of boys had increased, however. In addition, one experimental girl, two control girls, and five control boys were accelerated one-half year in mathematics. The gap in terms of mathematics acceleration between the experimental girls and the control boys appeared to be narrowing. By this time, at the end of tenth grade, twelve experimental girls, two control girls, and eight control boys had completed all of the courses that typically precede the study of calculus.

By the end of the 1976-77 school year, the students were completing the eleventh grade. Following a normal sequence, bright students in Baltimore who had begun algebra I in the eighth grade would be completing a year of trigonometry and analytic geometry or elementary functions in eleventh grade. Anyone who had completed a full year of mathematics beyond this was considered accelerated for the purposes of the 1977 follow-up. Eleven out of twenty-six experimental girls (42 percent), two out of twenty-five control girls (8 percent), and twelve out of twenty-six control boys (46 percent) were accelerated one year or more in mathematics. Based on the chi-square test, the differences between the experimental girls and the control boys were not significant, but the differences between the experimental girls and the control girls and between the control boys and the control girls were significant ($p < .05$).

Over the four-year period following the intervention (shown in table 10.2), the number of experimental girls accelerated remained fairly constant.

TABLE 10.2. Students accelerated at least one year in mathematics in 1974, 1975, 1976, and 1977

| Group | Number responding | Number accelerated | Percentage accelerated |
|---|---|---|---|
| | | 1974 | |
| Experimental girls | 26 | 10 | 39 |
| Control girls | 26 | 0 | 0 |
| Control boys | 26 | 0 | 0 |
| | | 1975 | |
| Experimental girls | 24 | 12 | 50 |
| Control girls | 25 | 4 | 16 |
| Control boys | 25 | 5 | 20 |
| | | 1976 | |
| Experimental girls | 25 | 12 | 48 |
| Control girls | 23 | 2 | 9 |
| Control boys | 26 | 8 | 31 |
| | | 1977 | |
| Experimental girls | 26 | 11 | 42 |
| Control girls | 25 | 2 | 8 |
| Control boys | 26 | 12 | 46 |

The number of control girls accelerated a full year in mathematics dropped from four girls in 1975 to only two in 1976, and that number remained the same in 1977. The number of control boys accelerated in mathematics, on the other hand, increased fairly dramatically over the four-year period, from zero to five to eight to twelve.

The boys accelerated in mathematics on their own, without the special class. Most of the control girls failed to accelerate. The experimental girls kept pace with the control boys in terms of number accelerated in mathematics, but the special class appears to have been an important factor in making that possible. Nine of the eleven experimental girls accelerated in mathematics in 1977 became accelerated by virtue of not repeating algebra I at the end of the summer course. The evidence strongly suggests, therefore, that some type of intervention is necessary to ensure that girls will persist in mathematics at the same rate that boys do.

*Follow-up studies of career interest.* In 1973, prior to the start of the special class, all three groups were tested on two measures of vocational interest. On an abbreviated form of the Vocational Preference Inventory (VPI), the boys showed significantly more interest in investigative careers than did either group of girls. On a questionnaire item, however, while

TABLE 10.3. Career interests of experimental and control groups

| Group | N | Number science/math | Number non-science | Percentage science/math |
|---|---|---|---|---|
| | 1973 pre-test | | | |
| Experimental girls | 26 | 10 | 16 | 39 |
| Accelerated experimental girls[a] | 11 | 6 | 5 | 55 |
| Control girls | 25 | 8 | 17 | 32 |
| Control boys | 25 | 15 | 10 | 60 |
| | 1974 post-test | | | |
| Experimental girls | 24 | 14 | 10 | 58 |
| Accelerated experimental girls[a] | 11 | 8 | 3 | 73 |
| Control girls | 24 | 9 | 15 | 38 |
| Control boys | 21 | 14 | 7 | 67 |
| | 1975 follow-up | | | |
| Experimental girls | 21 | 13 | 8 | 62 |
| Accelerated experimental girls[a] | 10 | 8 | 2 | 80 |
| Control girls | 25 | 10 | 15 | 40 |
| Control boys | 21 | 15 | 6 | 71 |
| | 1976 follow-up | | | |
| Experimental girls | 23 | 12 | 11 | 52 |
| Accelerated experimental girls[a] | 10 | 7 | 3 | 70 |
| Control girls | 23 | 14 | 9 | 61 |
| Control boys | 23 | 17 | 6 | 74 |

[a]Girls who accelerated immediately following intervention.

more boys than girls in either group stated a career preference in a mathematical or scientific area, the differences were not significant (Fox 1974).

Follow-up assessments of career interest were conducted in 1974, 1975, and 1976. The results of these follow-ups, as well as the results from the 1973 questionnaire, are summarized in table 10.3. By the end of the 1975-76 school year, there were no significant differences among the three groups. It does not seem that the intervention caused more girls to become interested in careers in mathematics and science. It appears, however, that experimental girls became interested in mathematics or science careers at an earlier age than the control girls. This early interest might affect course-taking and make the girls more willing to accelerate in mathematics in high school.

*Conclusion.* A comparison of the course-taking behavior of the control boys and of the control girls through 1977 supports the first hypothesis—that gifted boys and girls of equal ability in mathematics at grade seven and from similar home backgrounds will differ in the high-school years in terms of advanced courses in mathematics. Without any specific intervention designed to stimulate course-taking in mathematics, a greater percentage of control boys (46 percent) than control girls (8 percent) had accelerated themselves in mathematics.

The second hypothesis was that girls who received special encouragement and facilitation in mathematics vis-à-vis an accelerated algebra program would keep pace with or surpass their male and female cohorts with respect to course-taking. The experimental girls who participated in the special algebra class kept pace with the control boys in terms of acceleration (42 percent of the experimental girls and 46 percent of the control boys accelerated in 1977) and surpassed the number of control girls who accelerated (8 percent).

## SOME VARIABLES CONTRIBUTING TO DIFFERENTIAL COURSE-TAKING

What accounts for sex differences in mathematics course-taking? For the students in this study, mathematical ability was not a factor, since students were selected for the three groups on the basis of equal ability as measured by their SAT scores. An attempt was also made to control home variables by matching students on the basis of their father's education and occupation and their mother's education. In spite of this, sex differences were clearly evident in the course-taking behavior of the gifted students who were not in the intervention program. These sex differences in mathematics course-taking appear to be the result of different interests and differential encouragement by others.

### *Values*

One factor contributing to sex differences in mathematics course-taking may be that mathematically gifted boys and girls have different values. Studies have found high theoretical scores on the SV to be characteristic of mathematically precocious adolescent males, while mathematically gifted girls are more likely than boys to have high social or aesthetic value scores (Fox 1976*b*; Fox and Denham 1974). High scores on the theoretical scale are associated with interests in science and mathematics.

An analysis of the experimental and control groups in the intervention study revealed that on the SV, the experimental and control girls scored significantly higher than the control boys on the social scale ($p < .005$) and significantly lower on the theoretical scale ($p < .005$) (Fox 1976*b*).

Since mathematics courses generally do not emphasize the applied aspects of mathematics and thus its social relevance, gifted girls may find the courses less interesting and less relevant to their interests than gifted boys. This may discourage the girls from electing to take mathematics courses. Perhaps some of the many social applications of mathematics should be included in mathematics courses to encourage girls whose interests are primarily social but who have a high aptitude for mathematics to take advanced courses in mathematics.

## *Career Interests and the Perceived Usefulness of Mathematics*

Another factor contributing to differential mathematics course-taking may be the degree to which mathematics is perceived as useful for future career goals. A study of 67 girls and 104 boys selected from SMPY's 1974 mathematics talent search found girls to be significantly less likely than boys to report that mathematics would be very important to their future goals, and the girls were also less likely than the boys to name as career goals occupations of the type that require the most mathematical and scientific training (Fox 1975).

The Strong-Campbell Vocational Interest Inventory, when administered to the experimental and control groups in 1973, revealed sex differences. Control girls scored significantly higher than the control boys on the following scales: art, domestic arts, music/dramatics, nature, office practice, social service, teaching, writing ($p < .005$); religious activities ($p < .01$); and medical service ($p < .05$). The boys scored higher on mechanical activities and science ($p < .005$). The gifted girls scored higher in the mathematics and science areas than a comparison group of average girls, but not as high as the gifted boys (Fox, Pasternak, and Peiser 1976).

The results of following up career interest in the three groups in the intervention study have been summarized above and are shown in table 10.3. Included in table 10.3, as well, are the career interests of the eleven girls who accelerated immediately following the intervention by enrolling in algebra II. Eight of these girls (73 percent) expressed interest in a mathematical or scientific career in the 1974 post-test assessment of career interest. This suggests a possible relationship between interest in mathematical and scientific careers and willingness to accelerate in mathematics. A comparison of these eleven accelerated experimental girls with the control girls showed the accelerated experimental girls to be significantly more interested in mathematical and scientific careers than the control girls in 1974 and 1975. By 1976 this difference was no longer significant. Possibly the lack of interest early in the high-school years, however, was a factor in discouraging the control girls from accelerating in mathematics.

Other studies confirm a relationship between mathematics course-taking and the perceived career relevance of mathematics. Haven (1972) found that the two most significant predictors of mathematics course-taking in high school for girls of above-average ability were the perception of the usefulness of mathematics for future educational and career goals and greater interest in the natural sciences than in the social sciences. Sherman and Fennema (1977) also found that course-taking in high school was related to the perception of the usefulness of mathematics.

## *Differential Encouragement by Significant Others*

Another factor that may contribute to sex differences in mathematics course-taking is differential encouragement by significant others. Because of a perception that mathematics is a domain more appropriate for men than for women, girls receive less encouragement than boys do to take advanced mathematics courses and to consider careers in mathematical and scientific fields. The significant others include parents, counselors, teachers, and peers. Books and the media also contribute to the perception of mathematics as a male domain and thereby discourage girls from entering it.

Numerous studies suggest that girls receive little encouragement from counselors to pursue mathematics. For example, Haven (1972) found that 42 percent of the girls who were interested in careers in mathematics or science reported being discouraged by counselors from taking courses in advanced mathematics. In chapter 9 of this volume Patricia Casserly also reports that counselors admitted discouraging girls from taking advanced mathematics courses. Their reasons reflected their stereotype of mathematics as a male domain.

Teachers' stereotypes may also discourage girls. Solano (1977) found that teachers' perceptions of mathematically gifted girls are more negative than their perceptions of mathematically gifted boys. Studies of student-teacher interaction suggest that teachers interact more with boys than with girls, particularly in mathematics and science classes (Bean 1976; Good, Sikes, and Brophy 1973). Yet Casserly found that when teachers do take an interest and actively recruit girls for mathematics programs and expect them to perform as well as boys, the results are significantly positive (see chapter 9).

Another source of influence to consider is the peer group. If the perception of mathematics as a male domain is common in the peer group, girls may fear peer rejection for accelerating too much in mathematics. One study of adolescents found that they hold a more negative stereotype of mathematically gifted girls than they do of mathematically gifted boys (Solano 1977). Thus girls may be perceiving real peer pressure against high mathematics achievement; boys do not seem to feel this same pressure.

Girls are reluctant to skip a grade, take college courses early, or in any way separate themselves from their peer group. One girl was ready to abandon a grade skip in the first week of school and return to the lower grade because she had no friends with whom to eat lunch. Another mathematically gifted girl dropped out of an accelerated mathematics program only because her best friend did (Angel 1974).

Perhaps the most powerful influence on children comes from their parents. In one study, mathematically gifted boys were significantly more likely to perceive their parents as favorable toward acceleration in mathematics than were gifted girls (Fox 1975). Parents of mathematically gifted boys are more likely to report having bought scientific and mathematical games and toys for their sons than are parents of gifted girls; they are also more likely to have noticed their child's ability at an early age and to have discussed college and career plans with him (Astin 1974).

A questionnaire was administered to the parents of the students in the experimental and control groups of the intervention study in 1973, prior to the treatment, to assess the parents' feelings about careers and the usefulness of mathematics for their child's future. The parents were asked how important a knowledge of mathematics would be for the child's future career. Responses were received from forty-five parents (mothers and fathers) in each of the control groups and from forty-seven parents in the experimental group. These responses are summarized in table 10.4. Chi-square tests of significance revealed significant differences between the responses of the parents of the experimental girls and those of the parents of the control boys ($p < .001$) and between the responses of the parents of the control girls and those of the parents of the control boys ($p < .01$). There were no significant differences between the responses of the parents of the two groups of girls. The boys' parents seem, therefore, to perceive mathematics as more important for their child's future career than do the girls' parents, and this may result in differential encouragement to take advanced mathematics courses.

The parents were also asked to list careers that they would most like to see their child pursue. By dividing the first-choice responses into mathematical/scientific and nonmathematical/nonscientific groups, sex differences became apparent. Sixty-three percent of the boys' parents who responded listed a mathematical or scientific career as first choice, while only 39 percent and 33 percent of the parents of the experimental girls and the control girls, respectively, listed a mathematical or scientific career as first choice. The ratio between the groups of parents is similar to the ratio obtained between the boys and girls themselves when their own career interests were assessed in 1973, so the parents may be reflecting their children's true interests. Nonetheless, differential encouragement regarding advanced mathematics course-taking may result.

The girls' parents were also asked to state the amount of time they expected their daughter to devote to her career (see table 10.5). Only one

TABLE 10.4. Parents' opinion of importance of mathematics for their child's future career

| Parents of | Importance of mathematics: Very important | Fairly important | Slightly important | Not very important | Not at all important |
|---|---|---|---|---|---|
| Experimental girls | 36 | 49 | 13 | 2 | 0 |
| Control girls | 38 | 53 | 7 | 2 | 0 |
| Control boys | 58 | 40 | 2 | 0 | 0 |

TABLE 10.5. Parents' expectations of the amount of time they expect their daughter to devote to a career

| Expectation | Parents of experimental girls | | Parents of control girls | |
|---|---|---|---|---|
| | Number | Percentage | Number | Percentage |
| Daughter will not work after she marries | 1 | 2 | 1 | 2 |
| Daughter will probably work only until she has children | 5 | 11 | 8 | 17 |
| Daughter will probably have a full-time career, except while her children are preschool age | 22 | 47 | 14 | 30 |
| Daughter will probably have a full-time career even while her children are young | 5 | 11 | 12 | 26 |
| Daughter will probably have only a part-time career until her children are grown | 9 | 19 | 8 | 17 |
| Other | 5 | 11 | 3 | 7 |
| Total | 47 | 101[a] | 46 | 99[a] |

[a]Percentages do not total 100 because of rounding off.

parent of an experimental girl and one parent of a control girl did not expect their daughter to work at all after marrying. However, 11 percent of the experimental parents and 17 percent of the control parents expected their daughter to work only until she and her husband decided to have children. Forty-seven percent of the experimental parents and 30 percent of the control parents thought their daughter would have a full-time career except for the time when her children were of preschool age; 19 percent of the experimental parents and 17 percent of the control parents thought their daughter would have only a part-time career until her children were grown; and 11 percent of the experimental parents and 7 percent of the control parents did not want to predict what their daughter would do. Only 11 percent of the experimental girls' parents and 26 percent of the control girls' parents expected their daughter to have a full-time career even while her children were young, while presumably all the parents of the boys expect their sons to work full-time. This factor may contribute to differential encouragement. Although one father reported that he did not expect his daughter to work after she married, his aspiration was for her to become a doctor. This type of conflicting aspiration is presumably being transmitted to the child and surely must confuse her.

## CONCLUSIONS AND RECOMMENDATIONS

Competence in mathematics is an important prerequisite for a wide variety of careers, particularly those of a professional nature. In addition to careers in mathematics and the natural sciences, careers in business and the social sciences are requiring a strong background in mathematics because of their increasing use of statistics and computer technology. For this reason, it is important to encourage students to take advanced mathematics courses in high school so that any college or career option will be open to them.

The study described in this chapter suggests that gifted girls may need more encouragement to study advanced mathematics than do gifted boys. The gifted boys in this study were accelerating themselves in mathematics and electing advanced mathematics courses at a faster rate than were the control girls, who were not given special encouragement. The intervention program, however, appeared to make a difference. The girls in the treatment group kept pace with the boys in terms of mathematical acceleration.

Although the intervention was apparently successful, it is difficult to determine which element was the most important in contributing to that success: the all-girl nature of the class, the female role models, the career-education aspect, the emphasis on the social relevance of mathematics, the accelerative component, the individualized instruction, or a combination of some or all of the above. The research suggests that girls' values, interests, and career goals may differ from those of boys and that girls may receive less encouragement from significant others to take advanced mathematics courses and to consider careers in mathematics and science. The intervention was designed to counteract as many of these negative influences as possible simultaneously, and it appears to have been successful in this respect. Possibly it would be enough, however, to concentrate on heightening career interest or to provide a role model who could give continued encouragement. More research is needed. Under Title IX same-sex classes will be difficult to arrange under most situations. A study is underway comparing the intervention study described in this chapter with mixed-sex accelerated classes and with an all-girl career-education class that has no accelerative component to determine the effect of these programs on course-taking behavior. (The career-education class is described in chapter 11.)

Although an all-female environment may not be necessary, one thing to consider in setting up special mathematics classes for the gifted may be the need for a minimum number of girls in the program so that girls will continue and succeed. Sometimes when the number of girls is small, girls begin to drop out, presumably because the class has become too much of a "male domain."

Educators should be encouraged to counteract the perception of mathematics as a male domain and to encourage mathematically talented girls to take courses in advanced mathematics. In-service programs for teachers, counselors, and parents are needed to explain the effects of sex-typing mathematics and to show the relevance of mathematics to a wide variety of careers, including those in the social sciences. At the same time, educators should explore changes in educational policies so as to foster an atmosphere that encourages talented young women to take advanced mathematics courses. Some approaches might include: (1) requiring four years of high-school mathematics for everyone (thus eliminating negative peer pressure against taking mathematics); (2) sponsoring career-education classes for both boys and girls to alert them to the relevance of mathematics to so many careers in our increasingly technical society; (3) selecting textbooks that are non-sexist in their portrayal of roles in our society; (4) increasing the emphasis in mathematics classes on the social applications of mathematics; and (5) sponsoring fast-paced accelerated classes for gifted students in order to provide challenging mathematics instruction and a strongly supportive peer group for the girls in the class.

All mathematically gifted girls need not aspire to become mathematicians or physicists. On the other hand, girls who avoid advanced mathematics courses in high school eliminate a wide variety of college and career options for themselves because they lack the high-school prerequisites. These gifted girls need special encouragement and programs to counteract the image of mathematics as more relevant for men than for women and to show them how the study of mathematics may be relevant to a wide variety of college majors and careers.

## REFERENCES

Angel, M.F. 1974. Wolfson I: A study in precocious mathematical ability and education. Master's thesis, The Johns Hopkins University.

Astin, H. S. 1974. Sex differences in mathematical and scientific precocity. In *Mathematical talent: Discovery, description and development,* ed. J. C. Stanley; D. P. Keating; and L. H. Fox, pp. 70-86. Baltimore: Johns Hopkins University Press.

Bean, J. P. 1976. What's happening in mathematics and science classrooms: Student-teacher interactions. Paper presented at the meeting of the American Educational Research Association, San Francisco, April 1976.

Fox, L. H. 1974. Facilitating the development of mathematical talent in young women: Ph.D. diss., The Johns Hopkins University.

———. 1975. Career interests and mathematical acceleration for girls. Paper presented at the meeting of the American Psychological Association, Chicago, September 1975.

———. 1976*a*. Sex differences in mathematical precocity: Bridging the gap. In *Intellectual talent: Research and development,* ed. D. P. Keating, pp. 183-214. Baltimore: Johns Hopkins University Press.

———. 1976*b*. The values of gifted youth. In *Intellectual talent: Research and development,* ed. D. P. Keating, pp. 273-84. Baltimore: Johns Hopkins University Press.

Fox, L. H., and Denham, S. A. 1974. Values and career interests of mathematically and scientifically precocious youth. In *Mathematical talent: Discovery, description, and development,* ed. J. C. Stanley; D. P. Keating; and L. H. Fox, pp. 140-75. Baltimore: Johns Hopkins University Press.

Fox, L. H.; Pasternak, S. R.; and Peiser, N. L. 1976. Career related interests of adolescent boys and girls. In *Intellectual talent: Research and development,* ed. D. P. Keating, pp. 242-61. Baltimore: Johns Hopkins University Press.

George, W. C., and Denham, S. A. 1976. Curriculum experimentation for the mathematically talented. In *Intellectual talent: Research and development,* ed. D. P. Keating, pp. 103-31. Baltimore: Johns Hopkins University Press.

Good, T. L.; Sikes, J. N.; and Brophy, J. E. 1973. Effects of teacher sex and student sex on classroom interaction. *Journal of Educational Psychology* 65: 74-87.

Haven, E. W. 1972. Factors associated with the selection of advanced academic mathematics courses by girls in high school. Research bulletin 72-12. Princeton: Educational Testing Service.

Sherman, J. A., and Fennema, E. 1977. The study of mathematics among high school girls and boys: Related factors. *American Educational Research Journal* 14(2): 159-68.

Solano, C. H. 1977. Teacher and pupil stereotypes of gifted boys and girls. *Talents and Gifts* 19(4): 4.