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The Effects of Perceived Parental Evaluations on Skills Development in Mathematics

Donna M. Kaminski

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THE EFFECTS OF PERCEIVED PARENTAL EVALUATIONS ON SKILLS DEVELOPMENT IN MATHEMATICS

by

Donna M. Kaminski

A Thesis Submitted to the Faculty of The Graduate College in partial fulfillment of the Degree of Master of Arts

Western Michigan University
Kalamazoo, Michigan April 1975

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ACKNOWLEDGEMENTS

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And as always, my thanks to Char, my friend and companion, for his patience and uplifting diversions.

Donna M. Kaminski
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CHAPTER I
INTRODUCTION, LITERATURE AND THEORY

Introduction

Proportionally, far fewer women than men enter careers requiring advanced mathematical skills. Obviously, this is in part a consequence of the high school experience where, for example, far fewer female than male twelfth graders take courses in mathematics. Why is mathematical ability in American women inferior to that of males? Or, are women generally deterred from developing their mathematical skills by false stereotypes of their parents? From a theoretical position in the tradition of symbolic interactionism, this research presents evidence that one of the reasons fewer females than males elect to take twelfth grade mathematics courses is that during their earlier middle-school years these females tend to perceive lower parental evaluations of their mathematical aptitudes than do their male counterparts.

In examining male-female differences in mathematics, one might mistakenly expect the mathematics grades of males to be higher than those of females since grades are often used as a measure of ability and achievement. However, many studies
have shown that in the elementary and middle-school years, females consistently received higher grades for mathematics achievement than males of equal ability (Lewis, 1968).

A number of studies have tested the mathematical abilities of students at various ages and grade levels and have concluded that only after a certain grade--the seventh grade--do boys tend to attain greater mathematical skills than that shown by girls (Hilton & Berglund, 1974; Maccoby, 1966).

Before explaining male-female differences in mathematics, perhaps it is appropriate to discuss the relevance of differences in mathematics skills. What is the importance of acquiring advanced high school mathematical skills? To begin with, it is assumed that mathematics training develops one's ability in logic, efficiency, numerical relationships, quantitative reasoning, spatial reasoning and problem-solving; all these mental skills play a part in many aspects of an individual's everyday life. Additionally, there are more specific uses of mathematical skills. Skill in mathematics may directly affect one's future--such as the consequences of performance on tests related to estimations of general intelligence (e.g., IQ tests), tests assessing college readiness or scholarship, graduate or professional school aptitudes, civil service competencies, and job aptitudes and skills--
all of which have examination questions testing mathematical skills. For example, even clerical jobs may require an applicant to be able to divide, add and subtract efficiently and accurately.

The number of years of mathematics taken in high school may affect one's college years even if no mathematics major is intended. Some colleges and universities may require three or four years of high school mathematics for entrance or for entrance into specialized programs. Beginning calculus classes (which start at a level that presupposes students have passed four years of high school mathematics), may be required for certain majors such as engineering, physics, aviation technology, statistics or computer programming. The occupational gap between males and females widens in high school and beyond in correspondence with mathematics requirements. The student who does not develop mathematical skills, for whatever reason, is restricted from many occupational opportunities. If females are to attain economic and social equality, they will have to acquire the prerequisite skills of mathematics. It is not merely a matter of interest.

In studying the literature related to male and female academic abilities, one encounters an expanding body of work asserting the waste of female potential in the occupational
structure. This is not to say that all males have been able to utilize their potential. What is being emphasized here is that in addition to factors such as race, social class and poor training which discriminate against males and females alike, females may have as an additional status "burden," the mere fact of being female.

Ideologically we believe that all individuals have the right to realize their full occupational potential. In practice, however, this is refuted by the following findings concerning loss of occupational potential. The Terman & Oden (1959) longitudinal study of very high IQ individuals (IQ of 151+ at age ten) showed the occupational level of these subjects years later. While 86 percent of the men studied had achieved professional prominence, only 11 percent of the women were in similar professions. Thirty-seven percent of these high IQ women were nurses, librarians, and teachers, and 26 percent held secretarial or other clerical jobs. Our ideology is also contradicted by two studies conducted by Horner (1972) at Radcliffe College, where students are chosen primarily because of their records of high ability, achievement, motivation and previous success. By their junior year, most enrollees had changed their earlier distinguished-career plans to the traditional female fields.

Bruemmer (1969) also found college women increasingly
more interested in becoming housewives between their freshmen and senior years. Research by Bem & Bem (1970) noted that by the ninth grade, 25 percent of boys and only three percent of girls considered careers in science and engineering. Hawley (1971) found that a decline in career commitment in high school girls was related to their feelings that male classmates disapproved of a woman's using her intelligence. Frazier & Sadker (1973:140) noted, "Although adolescent girls view homemaking as inferior to careers that are open to men, they also feel that men view intelligent women with distaste and that marriage and a career are not really compatible."

Looking more specifically at academic potential, Maccoby's (1966) review of the literature on sex differences noted the following four studies: (1) Crandall, et al., (1962) asked children how well they expected to do on a new task. They found that the brighter a boy was the better he expected to do; but that the brighter a girl was, the less well she expected to do. Further, when asked whether their scores on the task were a function of chance or of their own efforts, the brighter boys more often felt success was due to their own efforts, while in girls no relationship was found between IQ and belief in self-responsibility. (2) Sears (1963) similarly found boys' self-appraisal to be
positively correlated with intelligence, but girls' self-appraisal was not. (3) Shaw & McCuen (1960) found that female under-achievers in high school usually began to underachieve at puberty; for males, this characteristic showed up in early elementary school, pointing to possibly differing reasons for underachievement. (4) Coleman (1961) studied students designated "best scholar" in high school and found that boys so named had higher IQ scores than girls so named. He suggests that at this age females may do less than their best since they are caught between the pressure of high academic achievement expectations from parents and teachers and the fear that they will be unpopular if they show high achievement. A study by Cross (1968) noted that although women receive higher grades in high school, they are less likely to feel they can do college work; and of the brightest high school graduates who do not go on to college, 75-90 percent are women.

These may be linked to Horners's (1972) concept of "motive to avoid success." In a study of University of Michigan undergraduates, she found 65 percent of the women to have this fear as compared to only 10 percent of the men. In subsequent studies she found the percentage of women exhibiting this trait to range from 47 percent (in a study of seventh grade girls) to 86 percent
(in a study of Harvard Law School women). She adds, "Unfortunately, in American society even today, femininity and competitive achievement continue to be viewed as two desirable but mutually exclusive ends . . ." (Horner, 1972:8). Kagan & Freeman (1963) found that girls who rejected the traditional feminine role scored higher on intelligence tests than girls who conformed to it. Other investigations by Komarovsky, Rossi, Maccoby, Hoffman, and Broverman (cited by Blake, 1974:145) report in their general findings that American women are socialized for defeat while men are socialized for success in the areas of competition, independence, competence, intellectual achievement and leadership.

In summary, a cursory review of the literature indicates that much female potential has gone untapped academically, occupationally and socially. It is difficult to predict what a blue-blanketed baby will be 25 years later, but in all probability in the United States, the pink-blanketed baby will become a teacher, nurse, secretary, housewife and/or mother, regardless of her individual abilities. If a little girl wants to help sick people when she grows up, she is told that girls are nurses and boys are doctors. This occupational choice is not based strictly on "adult reality"--there have been many more female doctors
and lawyers than male astronauts and presidents.

By adolescence, females have learned to let males win in competitive situations, not only in games or sports, but socially and academically as well. This tendency carries on into many adult relationships. A 1969 study at Stanford (cited by Frazier & Sadker, 1973) found that 40 percent of the females admitted "playing dumb" on dates. This replicates the results found on women 25 years ago--40 percent of Barnard women studied in 1947 and 46 percent of Stanford women studied in 1949 admitted to "playing dumb" for their dates. This is not surprising as it fits in with Komarovsky's (1973) findings on seniors in 1970 at an Eastern Ivy League school: most of these males stated that they would prefer a wife who was less intelligent than they themselves were.

Should the woman decide to get a job, on the average she will earn only three-fifths of what a man will earn (though the difference decreases slightly if they are doing the same work). A female college graduate can expect to be paid less than males who dropped out of high school. A woman who does not happen to fit the mathematics stereotype will discover that female mathematicians earn only two-thirds as much as their male counterparts, (earning figures are based on median income; U. S. Department of Labor,
1971). For many women today, who they are in life is not dependent on what they do, but on what their husbands do. It should come as no surprise that the adolescent female begins to place high priority on "husband-getting," since society regards the male as Somebody and the female as that Somebody's wife. The plight of women may have been over-simplified and over-generalized in the above descriptions since many awakenings and social changes have been accomplished with the recent advent of the Liberation Movement. Nevertheless, research points to a greater need for change.

Related Literature

This section will present literature related to the research questions to be answered in this study. The first area to be considered will be male-female differences in mathematics followed by a review of what explanations have been given for them. The next area will deal with research related to sex differences in self-concept and expectations. It will be followed by a review of the literature showing relationships between expectations, self-concept and behavior. The final area to be considered here will report research involving expectations and self-concept in relation to mathematics.
Male-female differences in mathematics

A number of studies have dealt with the question, "Are there sex differences in mathematical ability?" Different studies have arrived at seemingly contradictory results. However, many of these differences in results can be explained in terms of the varying ages of subjects and the types of mathematical skills measured—such as numerical ability, spatial relations, memorization, perceptual speed, analytic ability, mechanical ability, abstract reasoning, and problem solving. The findings of some studies made since 1960 follow. (Pre-1960 studies found varied results similar to these.)

Most studies of young children found little or no significant differences between the sexes in mathematical abilities. A number of studies of pre-school children and early elementary students found no significant differences between the sexes in mathematics (see Fennema, 1973 for a review). Lesser, et al. (1965) and Hervey (1966) both found that boys did better on verbal problem solving. A study by Douglas (1964) of 3,000 eight year olds found differences in mathematical superiority along class lines; middle class boys were superior, while working class girls were superior. Minuchin (1964) also studied nine year olds, and found boys superior in problem solving and girls ahead

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in perceptual speed. These findings were true only in traditional schools; no significant differences were discovered in modern schools. Wozencraft's (1963) study of eight year olds using standard achievement tests reported girls to be superior in the 90-110 IQ range, but no significant differences between the sexes were found for lower and higher IQ students.

Research on students in upper elementary grades also fails to find consistent sex differences in mathematical ability. Here again, many studies report no significant differences in mathematics using standard achievement tests (see Fennema, 1973 for a review).

Other studies did establish sex differences in specific mathematical skills. Wozencraft (1963) found sixth grade girls were superior in computation (using standard achievement tests). Parsley, et al. (1964) studied fourth through eighth grade students and reported that in computation, girls were superior in the 75-125 IQ range and boys were superior above 125 IQ. A longitudinal study of students from fourth through eighth grades by Carry & Weaver (1969) and Carry (1970) found that boys were superior on 38 out of 75 tests, particularly in the area of application and analysis; girls were superior on 16 of the 75 tests administered during those five years, particularly in the computation area. A longitudinal study of seventh through tenth graders
by Kilpatrick and McLeod (1971) and McLeod and Kilpatrick (1969, 1971) found that boys excelled in 25 of the 51 tests and girls excelled in 10 of the 51 tests administered. Areas of superiority were similar to those in the Carry and Weaver studies. Jarvis (1964) found that boys were better at reasoning, girls at fundamentals. Muscio (1962) found that boys excelled in quantitative reasoning and understanding. Cunningham (1965) found seven to twelve year old boys superior in set-breaking. Olander and Ehmer (1971) found girls ahead in math vocabulary. Both Gainer's (1962) study of six to twelve year olds and McGuire's (1961) study of twelve to fourteen year olds found girls ahead in perceptual speed.

It should be mentioned here that most of the studies which found one sex ahead in mathematics found only small differences in ability. Further, there was considerable overlap of the sexes' abilities. Many individual females were better than many individual males, even though the male average was higher.

Sex differences do increase with age, however. Part of this expanding ability-gap may be accounted for by the differences in dropout rates and amount of prior mathematics preparation, as will be explained following the next paragraph.

Studies done at the high school level and beyond have more uniform results. The study of ninth grade students by Sheehan
(1968) seems to be the only study which found girls to be slightly superior--this was in the problem solving area. Flannigan, et al. (1964) found that males were clearly superior in arithmetical reasoning by the twelfth grade, though this was not so of ninth grade students. A longitudinal study by Hilton and Berglund (1974) following students from fifth through eleventh grades found that a difference in mathematical ability began to emerge between the seventh and ninth grades in favor of the males. Sweeny (1953) found that college males did better on reasoning tasks, especially those involving restructuring. Rosenberg and Sutton-Smith (1964) also found that college men performed significantly better on quantitative tests. Rossi (1969) found that females' performance on the mathematics portion of the SAT was inferior to that of males in high school and beyond. According to Bem and Bem (1970), men scored 50 points higher than women on the Math College Board Exam. Osbourne and Sanders (1954) found that men scored significantly higher on the mathematics portion of the Graduate Record Exam as well. Maccoby (1966), Jacklin and Maccoby (1972), and Maccoby and Jacklin (1974), after reviewing the research on sex differences, concluded that girls and boys are equal in mathematical ability in childhood, but at age twelve or thirteen boys begin to surpass girls and remain ahead throughout adulthood. This superiority was particularly noted in the area of
spatial ability.

Caution should be used in interpreting the differential mathematical ability in the high school years and beyond. There are additional factors which must be taken into account when comparing male and female averages. First the populations from which the two averages are obtained are no longer completely comparable once students have reached the age at which they may drop out of school. It has been generally found that more males than females drop out of school; that males drop out earlier than females; and that more lower ability than higher ability students drop out. Hence, the female average may be lower because its population includes more of the low ability students, whereas the male counterparts of some of these low ability females have dropped out and are not included in the male average. One must also consider that in general the more mathematics classes one takes in high school, the better one will probably do on ability tests in mathematics at that level and beyond. The U. S. Department of H. E. W. (1968) found that twice as many males as females took advanced mathematics courses. Hence, some of the variance between male and female mathematical ability in high school and beyond may be in part accounted for by their differences in preparation. These points may or may not have been taken into account in studies done after junior high school.
The sex differences in mathematical abilities must be viewed in proper perspective. To say that females are not competent in mathematics overstates the conclusion which research suggests. Yet this seems to be what has happened in many cases. Howe (1971) found that teachers assume that girls are likely to love reading and to hate mathematics and science. Broverman and colleagues (Blake, 1974:146) sampled psychologists, psychiatrists and social workers and concluded: "Clinicians are likely to suggest that healthy women . . . dislike math and science." In answer to this, one might note that "within-sex-differences" are no doubt greater than "between-sex-differences." One might also look at the number of mathematics degrees earned to note this point, where one can generally assume that a mathematics major will have higher mathematical ability than a non-mathematics major.

TABLE 1.1.--Percentage of degrees earned by females in 1970

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<th>Bachelors</th>
<th>Masters</th>
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<tr>
<td>Total Degrees</td>
<td>43%</td>
<td>40%</td>
<td>14%</td>
</tr>
<tr>
<td>Math Degrees</td>
<td>38</td>
<td>29</td>
<td>8</td>
</tr>
<tr>
<td>Math Education Degrees</td>
<td>51</td>
<td>45</td>
<td>31</td>
</tr>
<tr>
<td>Math &amp; Math Education Degrees</td>
<td>39</td>
<td>31</td>
<td>9</td>
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In comparing the sets of figures in Table 1.1, one can certainly see that not all women are poor in mathematical skills. The proportion of female mathematics majors is probably surprisingly higher than most people would expect. Yet, there is room for improvement. While mathematics and mathematics education degrees make up 2.90 percent of the total degrees earned by women, these two make up 3.46 percent of the degrees earned by men.

**Why are there sex differences in mathematical skills?**

If there are sex differences in mathematical ability, the next question is whether the cause of these differences is inherent or socio-cultural. A study by Dalton (1968) suggested that hormones may be related to mathematical ability. In this study progesterone was administered in the treatment of toxemias of pregnancy. Thirty toxemias mothers received progesterone, 29 did not, and 21 "normal" mothers were used as a control group. The children of these 80 pregnant mothers were later studied. The progesterone children of both sexes received significantly more "above average" grades in mathematics (and in most other subjects) than both the non-progesterone and the normal control groups. It was also found that there was a decrease in the child's
achievement from high dosage to low dosage of progesterone.

These results suggest that hormonal differences may account for some ability differences in mathematics. However, since grades were used as an ability measure, hormonal differences may not be affecting intellectual ability, but instead such things as "good behavior," teacher-pleasing behavior, or less physical activity. Additionally, these findings were not analyzed by sex of child.

A well-controlled experiment was conducted by Broverman (cited by Jacklin & Maccoby, 1972) in which either testosterone or saline solutions were given to male subjects. The results gave evidence that subjects who were given testosterone were better at simple subtraction problems. However, no evidence was revealed to show that this was not a general arousal effect. Neither of the above studies showed male-female differences, but rather suggested that hormones may play a part in differential mathematical ability.

Witkin, et al. (1954) found that females as a group tend toward a global or contextual approach in perceptual and intellectual functioning, whereas males tend toward the analytical approach. That is, females are more field dependent, they cling to the external context of a perceptual situation and are more
influenced by misleading cues. Whether this is genetic or learned was not clearly specified. However, in response to this, Maccoby, et al. (1965) and Sigel, et al. (1963) did not find this difference in four and five year olds. Smith (1964) found that spatial mechanical ability was less well-developed in females and that this aspect of mathematics becomes increasingly important in high school. Early levels of arithmetic involve more skills in rote memorization and computation (in which the sexes do not differ); later levels of mathematics involve more spatial and abstract skills.

A more sociological explanation of the sex difference in mathematical ability lies in the sex-role identification process though there were several approaches to this explanation. Milton (1957) suggested that the feminine role is more verbal, the masculine role is more quantitative—hence, different skills are developed. Along this same line, Carlsmith (1964) saw modeling of the same-sex parent as the root of the differential quantitative ability—mothers are more verbal generally, fathers are usually better at quantitative tasks. Carrying this a step further, Bieri's (1960) study of undergraduate women and Plank and Plank's (1954) study of the autobiographies of outstanding women mathematicians found that analytical ability was strongly associated with a high
level of identification with, and a strong attachment to, fathers rather than mothers. Feierabend (1960) likewise found that interest and ability in mathematics were a consequence of masculine identification.

Lynn (1972) tied sex-role identification to differential mathematical ability somewhat differently. There are two types of learning tasks: the "problem," in which the learner must explore the situation and determine the goal, and the "lesson," in which the exploration and goal-setting stages are minimized and learning comes about through memorizing what is presented. These two roughly parallel male and female sex-role learning. The female model (mother) is generally present in the early development years from which the female may imitate or memorize her appropriate role. The male model (father) on the other hand, is generally absent during much of this development stage. The male child must solve the male role "problem" from largely negative admonishments and must restructure these and define the masculine role as his goal. Relating this to mathematical abilities, the "lesson" for females and the "problem" for males in their appropriate sex-role development results in reinforcement of memorization skills in girls and problem-solving skills in boys.

Several studies suggested that sex differences in independence
training may account for differential ability in mathematics. A study of Eskimos by Berry (1966) found that there were no sex differences in spatial ability. United States studies involving tests of spatial ability seem to find males consistently superior while the results from tests measuring other aspects of mathematics do not yield such consistent results (see Maccoby, 1966; Maccoby & Jacklin, 1974). MacArthur (1967) replicated these results in his own test of two other populations of Eskimos. Both studies noted that Eskimo girls and women are very independent compared to our culture's definitions of female roles. The Munroe and Munroe (1971) study in Kenya found that children who were most independent were the best on spatial tasks. Minuchin, et al. (1969) found that girls in contemporary schools did much better in tests of spatial ability than girls from traditional schools. They suggested that contemporary schools would place more value on equality for females which would include independence. Also, Svensson's (1971) study of Swedish students (where a high emphasis is placed on sex equality) did not find any clear cut sex differences of mathematical ability as compared with similar U. S. studies.

Further socio-cultural explanations for these sex differences are offered by Aiken (1972) and Carey (1958) who found that a positive attitude towards mathematics was highly correlated with
problem solving ability. This in itself may not shed much light on
the sex-based differences, but in conjunction with the following
may help to explain them. Kagan (1966), Elton and Rose (1967)
and Riesman (1965) all suggested that females avoid mathematics
because it is viewed as a male subject and may serve to
"defeminize" them. This become particularly noted at adoles-
cence when the divergence of the two sex roles becomes ever
more apparent and sociologically important. This also coincides
with the age when males begin to show higher mathematical
ability. Hilton and Berglund's (1974) longitudinal study suggests
that the instrumental value of mathematics plays a large part in
explaining the sex differences. They found that in early high
school mathematical ability was highly correlated with the opinion
that mathematics will be useful in earning a living in the future.
And to all this, after her extensive review of the sex difference
literature, Maccoby (1966:40) adds, "... members of each sex
are encouraged in and become interested in and proficient at, the
kinds of tasks that are most relevant to the roles they fill currently
or are expected to fill in the future."

**Sex differences in expectations**

A number of studies have revealed that parents hold higher
achievement expectations for males than for females. These lend positive support for the suspected negative relationship between sex and perceived parental evaluations in the causal model adopted in this thesis.

Poffenberger and Norton’s (1963) study of college students found that parents' achievement expectations in college algebra were higher for males than females. Brookover and Gottlieb (1964) likewise noted that differences in expectations for males and females as students in mathematics are widely recognized. Aberle and Naegle (1952) found that fathers held higher achievement expectations for their sons than for their daughters. Baumrind (1972) also noted that parents had higher achievement expectations for boys than girls. Luszki and Schmuck (1965) found that boys perceived more parental academic achievement pressure than did girls.

It is also widely noted that females are generally more suggestibly, more conforming, and more dependent on the opinions of others. This suggests the importance of parental expectations for females' achievement behavior. Having lower parental expectations of one’s mathematical ability would then be even more detrimental to females. Patel and Gordon (1960) found high school girls to be more suggestible than boys and particularly responsive to higher prestige persons. Sears (1963) found that
females' desire for social approval motivated their achievement efforts. Crandall, et al. (1962) also found that achievement and "approval-seeking" from adults were related for girls, but not for boys. Johnson (1970) noted that when a child has a need for social approval from adults, expectations will have a more powerful influence on his or her self attitudes. From this, one might suspect that the relationship of expectations, self-concept and taking mathematics may differ for males and females.

**Sex differences in self-concept**

Studies in this area have not given consistent findings as to whether males or females have higher self-concepts. McKee and Sherriffs (1957) found females' self-concept to be lower than males--however, self-concept in this instance was defined more in terms of self-liking of one's sex role stereotype. Bohan (1973) found in testing students in the fourth, sixth, eighth, and tenth grades that only in the tenth grade did females have a significantly lower self-concept (here self-concept referred to a measure of self-esteem). Shaw and Alves (1963) found female underachievers were more negative than males in their perception of how others perceived them. Carrol (1967) and Bledsoe (1967) also found in research on students in the fourth through eleventh grades that girls had higher self-concepts than boys. However,
many of these results are essentially not comparable since, in most instances, a number of different phenomena were being measured by "self-concept," rather than a role-specific self-concept of ability as used in this study. Brookover, et al. (1967:20) summarized the findings on sex differences in self-concept,

"... an examination of research on whether there are sex differences in self-concept discloses what appear to be contradictory findings... When the self-concept instrument taps conforming social behavior, a higher level of self-concept for females is noted... when the instrument taps specific self-definitions of academic ability, lower scores are observed for girls...

Wylie (1968:772) noted several studies which did measure self-concept of academic ability. These studies found that females had lower self-concepts of their academic ability even though they were equal or superior to a comparable male group on academic aptitude tests. Brookover, et al. (1962) on the other hand found that in the seventh grade females' self-concept of ability was significantly higher than males.

**Expectations, self-concept and behavior**

The relationship of expectations, self-concept and behavior will be discussed in more detail in the following theory section.
Briefly though, self-concept is an intervening variable between the perceived evaluations of significant others and one's behavior. A student's self-concept of ability is based on the student's perceptions of the evaluations of others. The self-concept of academic ability functions to direct the student's academic behavior. Self-concept is, however, a threshold variable—a necessary condition for achievement but not sufficient in itself.

The relationships between expectations and self-concept and between self-concept and behavior have been widely supported by the literature (Johnson, 1970:88-92). For instance, Helper (1960) found that children's self evaluations reflected their parents' evaluations of them, particularly the mothers'. Rosenthal (1966) found that teacher's expectations were positively related to students' self-perceptions. Shapiro (1962) also found that peer expectations were influential for elementary students. Brookover et al. (1967) found a significant relationship between students' perceptions of their parents' evaluations and their self-concept of academic ability in a study involving seventh through twelfth grade students. The self-concept of ability was, in turn, positively related to the student's grade point average. Jones and Strowing (1968) found a significant correlation between self-concept and GPA, .51 for males and .67 for females. Clarke (1960) found a positive relationship between perceived academic
expectations of significant others and a student's college academic performance. Payne and Farquhar (1962) found that self-concept was significant in the differential motivation of high and low achieving students.

**Expectations and self-concept in relation to mathematics**

A number of studies have used the variables expectations and self-concept specifically in relation to mathematics. However, few have used both together in relation to mathematics.

Carey (1955) found that college women's problem solving ability could be improved through group discussions aimed at improving confidence in their ability at the task; this was not true for males. Alpert et al. (1963) found that students' attitudes toward mathematics were related to their parents' expectations and attitudes toward mathematics. Shapiro (1962) found that for elementary school females, peer attitude toward mathematics was influential on females' attitudes toward mathematics. Aiken and Dreger (1961) found that parents' emphasis and encouragement in mathematics was slightly more significant for females' attitudes toward mathematics than for males. Poffenberger and Norton (1963) studied college freshmen in 1955 and 1960 (post-Sputnik) focusing on the students' perceived parental evaluations of their
mathematical ability, their liking of mathematics and their mathematics grades. Although both sexes had higher mathematics grades in 1960 than in 1955, males showed the greatest improvement. Males also showed an increase in liking mathematics, but females did not. In 1955, the perceived parental expectations of males and females did not differ. Although both sexes' expectations were higher in 1960, males' perceived expectations increased significantly more than females. Sells (1973) found that social support from teachers, parents and peers was positively related to pursuit of advanced high school mathematics courses and with the student's performance in them. Koch (1972) found a significant relationship between self-concept, a general self-esteem measure, and mathematical achievement in rural area sixth graders. However, correlations for different classrooms varied from -.31 to .75. Backman (1970) studied 408 seventh grade students and found a positive correlation (.55 for females and .48 for males) between self-concept of mathematical ability and mathematical achievement using standardized achievement tests. Brookover, et al. (1962) found a significant relationship between self-concept of mathematical ability and mathematics grade for seventh grade students (with a higher correlation for males than females). These researchers also studied a special group of the above students,
the under-achievers. In this group, self-concept of mathematical ability was correlated with perceived mathematics evaluations of parents, best friend, and favorite teacher.

Theoretical Orientation

The concept of Self has been viewed from a number of differing theoretical perspectives. The approach used here is the Symbolic Interactionist view of George Herbert Mead (1934). This theoretical orientation will present a framework for relating self-concept to evaluations and to behavior.

According to Mead, the Self is initially dependent on the existence of a social system for its emergence. It is in this social setting that the Self develops through social communication or symbolic interaction. In this interaction, others react to the individual as an object whereby individuals learn to think of themselves as objects also, with feelings and attitudes about themselves. By responding to one's Self as others do, one develops the capacity to take the point of view of others with reference to oneself.

As mentioned earlier, there are many theoretical orientations to the concept of Self (for further elaboration see Hall & Lindzey, 1957; Wylie, 1968; Backman & Secord, 1968; and Hamachek, 1971). One dimension of Self on which theorists
disagree is whether the Self is an object or a process, as noted by Hall and Lindzey. The Self-as-object refers to the attitudes, feelings, judgments and evaluations one has about one's behaviors, abilities and worth. The Self-as-process refers to activities as thinking, perceiving, and coping with the environment which governs behavior. Some theorists have incorporated both concepts into their Self-theories, labeling them Self and Ego, respectively, but there has been no consistent convention in regard to this. Others, such as Snygg and Combs, use Self as both object and doer (in their "Phenomenal-Self"). Adler's Self is the agent, and his "Self-ideal" refers to Self-as-object. Jung, Horney and Rogers also use Self to refer to the psychological process, whereas "conscious ideal," "idealized image," and "self-concept" refer to Self-as-object. Mead uses the term Self to refer to the process by which the individual identifies himself or herself as a social object--the act of characterizing oneself. Mead describes the Self as being reflexive; the Self is, thus, a process rather than an object.

There is also disagreement as to the initial development of the Self. In Maslow's view, the Self develops from the unfolding of one's inner nature, pressing to satisfy the self-actualizing needs. Rogers, too, feels that the Self strives to actualize
itself; however, he believes the Self emerges from experience rather than the inner nature. Combs and Snygg see the Self resulting from an interplay of internal and external forces known only intuitively. To Adler, the Self develops through conscious behavior based on one's life plan. Sullivan sees Self arising through interpersonal situations where one receives a never-ending flow of reflected appraisals. In the Meadian view, initially no Self exists, but it develops through social interaction.

Another disagreement on the meaning of Self concerns whether it is a unitary or a multidimensional phenomena. Theorists viewing the Self as a unitary concept include Adler, Rogers and Goffman. James, Brookover and Kinch see Self as multidimensional, where the various dimensions of Self are role-specific. On this, Mead falls into the latter tradition (1934:142),

"... we carry on a whole series of different relationships to different people. We are one thing to one man and another thing to another... We divide ourselves up in all sorts of different selves with reference to our acquaintances... A multiple personality is in a certain sense normal, as I have just pointed out."

Mead's Symbolic Interactionist theory of Self has been formalized by Kinch (1963, from Johnson, 1970:84-5). He defined three postulates involving four basic variables: self-concept, perceived responses of others, actual responses of others, and behavior. From the first three postulates, it is possible to
logically deduce the latter three.

"1. The individual's self-concept is based on his perception of the way others are responding to him.

2. The individual's self-concept functions to direct his behavior.

3. The individual's perception of the responses of others toward him reflects the actual responses of the others toward him.

4. The way the individual perceives the responses of others toward him will influence his behavior.

5. The actual responses of others to the individual will determine the way he sees himself (his self-concept).

6. The actual response of others toward the individual will affect the behavior of the individual."

The above four variables are causally related in these six postulates. The actual responses of others towards the individual will determine how he or she perceives the responses of others; these perceptions will influence the individual's self-concept, which, in turn, guides his or her behavior. The evaluations of others are then indirectly related to behavior as pointed out by Brookover and Gottlieb (1964:469), "... for the expectations of others to be functional in a particular individual's behavior, they must be internalized and become part of the person's conception of himself." The variables used in this study which parallel
these are the perceived parental evaluations of mathematical
ability, the self-concept of mathematical ability, and taking
twelfth grade mathematics.

The Meadian view emphasizes the importance of interaction
with others in the development of one's self-concept. Other
theorists agree with Mead on this point. Rogers saw the Self as
being formed through interaction with the environment, but
particularly as a result of evaluational interactions with others.
Cooley also recognized the importance of the social milieu from
which a person comes--the Self was seen to grow as a consequence
of interpersonal interactions (from which he posited the concept
of "looking-glass self"). Closely related to these was Sullivan's
interpersonal theory of personality development. He saw the
individual as being immersed in a continual stream of inter-
personal situations in which the individual is the recipient of a
never-ending flow of "reflected appraisals"; from this the individual
develops expectations and attitudes toward his or her Self.

Kinch's postulates also emphasize the importance of the
individual's perception of reality as separate from "true reality."
This dimension of Mead's Self theory is also emphasized by other
theorists as Rogers, in his second proposition, "The organism
reacts to the field as it is experienced and perceived..." (Hall
& Lindzey, 1957:479). Cooley states, "We can see here, in the
process of self appraisal by an individual, the importance of his accurate perception and interpretation of the reaction of the other person to him..." (Hamachek, 1971:49). Backman and Secord (1968:43) note that on looking at self-concept, "... also involved here is the concept of reflected self--an individual's estimate of how persons important to him would describe him."

Mead is referred to as a "Social Behaviorist" on the basis of his assumption that the organism responds to stimuli (as in Kinch's sixth postulate above). This is, however, not a passive response. The organism dynamically selects its stimuli and, hence, to a great extent, determines its environment. According to Mead (1934:25),

"... attention enables us to organize the field in which we are going to act. Here we have the organism as acting and determining the environment. It is not simply a set of passive senses played upon by the stimuli that come from without."

This indicates that all expectations of others are not internalized to the same degree in influencing the individual's self-concept. The evaluations of certain people are more important than the evaluations of other people; namely, those of one's significant others. Also, the individual must accurately perceive the responses of others in order to internalize them. Backman and Secord (1968) note that the individual also compares new expectations against a standard set of already existing expectations as to
how he or she should behave. Brookover and Erickson (1969) point out that the importance others attach to their expectations, and the perceived surveillance of the others as to whether their expectations are carried out, will affect whether or not the expectations are internalized. Specifically, "Importance and surveillance are conditions which tend to obligate the individual to carry out the expectations of others." (Brookover & Erickson, 1969:78) Johnson (1970) notes that certain personality variables of the individual will influence the effectiveness of others' expectations. For instance, students who are adult-oriented and who have a high need for social approval from adults would be more affected by adult-expectations. As noted in the previous section, this would more often characterize females than males. It must also be emphasized that self-concept of ability is a threshold variable with respect to behavior, a necessary but not sufficient condition. The self-concept of academic ability, then, sets functional limits on learning, apart from the organic limits set genetically.

The above Symbolic Interactionist approach to Self is the theoretical orientation used in this study. The variables perceived evaluations, self-concept and taking mathematics are causally related as follows.

The student's perceived parental evaluations of his or her mathematical ability influence the student's self-concept in the
area of mathematical ability. This mathematical self-concept functions to direct the student's mathematics-related behavior—in this case, taking mathematics in the twelfth grade. These relationships will be analyzed in the following chapters in relation to the variable sex, with control variables IQ and social class.
CHAPTER II
RESEARCH METHODS

The Data

The data used in this research was from a longitudinal study conducted by Brookover and associates (1962, 1965, 1967) carried on during the academic years 1960-61 through 1965-66—the student years for the current adult cohort this study is attempting to explain. Each year questionnaires were administered and school records obtained for a "class" of students as they moved from seventh grade through twelfth grade. The students originally attended four junior high schools in a city with a population of approximately 110,000. These four schools then fed into three senior high schools.

This study uses the eighth and twelfth grade data which include 303 females and 255 males. Certain of the total number of students were not able to be included in this data, such as those on whom complete data was not available, those who were not regularly promoted, those in special education programs, and non-Caucasians. Because of the longitudinal nature of the study, any students who moved into or out of the school system were also excluded. Because this was an urban school system,
possibly more students from higher social classes were excluded
due to moving out of the district to suburban areas. On the other
hand, school drop-outs would also have been excluded who might
tend to have been from a lower social class. The exclusion of
drop-outs may also tend to raise the average IQ since lower IQ
students are more likely to leave school. Further, since males
are generally more likely to leave school, male-female comparisons
may tend to favor males as a group, if the drop-outs were indeed of
lower than average ability. Whether the "complete data available"
restriction of this research biases the present study is difficult to
accurately determine. However, the theory does not restrict
itself to any given subpopulation. These restrictions, then, are
probably not of sufficient magnitude so as to invalidate this re-
search.

There are some drawbacks to using secondary data as this.
The type of information which was gathered was geared to the
specific questions and hypothesis with which the original study
was concerned. But because of the range of information collected,
it was possible to obtain the necessary data. However, had data
been collected specifically for this study, some of the more
general academic questions would have been directed more
specifically towards mathematics.

The eighth grade data was collected in the 1961-62 school
year, which is now over thirteen years old. The age of this information actually makes it more valuable in many respects. The data relevantly describes characteristics of the high school experience of today's twenty-six year olds, the young adult population for which generalizations are sought in this study. Furthermore, while differing historically from today's eighth grade students, the theoretical relationship of the variables remains virtually unchanged. The theoretical perspective relating perceived evaluations, self-concept of academic ability and academic behavior remains as applicable then as now. Through studying these high school characteristics of today's young adults, further light may be shed on why women are as they are today; particularly, why today's adult women are stereotyped as being inferior to men in the area of mathematics.

The selection of grades eight and twelve in which to measure the variables does have certain advantages. The twelfth grade was chosen for measuring the variable "taking mathematics" as it was the last available year in the original study. This made it the "closest to adulthood" measure of those who may consider themselves to be competent in mathematics as adults. The eighth grade was selected in which to measure the predictor variables for two reasons. First, the eighth grade was the last grade in which mathematics was a required course for all
students. Hence, the problem of differential mathematical back-
grounds, insofar as the number of years of mathematics taken
and recentness of the last mathematics course, was not introduced.
Second, it is at this age that sex differences in mathematical
ability begin to appear, according to the literature previously
cited. In other words, sex differences in parental evaluations in
mathematics should be somewhat more pronounced at this age
than in the seventh grade.

There are, of course, empirical and theoretical difficulties
in relating data measured four years apart. In effect, four years
of intervening variables have occurred which makes prediction
that much more difficult. These ninth through twelfth grade
variables certainly would affect a student's decision-making in
the twelfth grade. For this reason, one may expect to explain
less of the variance in the variable taking twelfth grade mathe-
matics than might be expected from measuring all of the inter-
vening variables. As a consequence, this is a very conservative
test of the hypothesized relationships between eighth grade entry
and twelfth grade entry into mathematics.

The Variables

The data for each student was obtained from both a ques-
tionnaire administered in the fall of the eighth grade, and the
student's school records (for such information as father's occupation and IQ score).

Sex

This variable was coded with a "1" for males, and a "2" for females. Of the 558 students included in this study, 303 were female, 255 were male.

Intelligence quotient (IQ)

This ability measure was obtained from the student's school record as an average of fourth and sixth grade IQ scores. This was the most current IQ score available prior to the administration of the questionnaires in the eighth grade.

Socio-economic status (SES)

The social class variable was obtained from the student's eighth grade school records based on the occupation of the student's father, or whoever was supporting the family. The Duncan Scale was used where values range from 1 to 99, with 1 being the lowest and 99 being the highest.

Perceived parental evaluation of mathematical ability (PPEMA)

This variable was measured by the student's response to
the question, "What grade do you think your parents would say you are capable of getting in mathematics?" Scores range from 5 (among the best) to 1 (among the poorest). This variable was measured in the eighth grade.

**Self-concept of mathematical ability (SCMA)**

This score was operationally defined as the sum of the scored responses to the eight-item *Michigan State University Self-Concept of Ability in Specific Subjects Scale* (in mathematics) -- see the Appendix. Each item was scored from 1 through 5 giving a total possible range from 8 to 40 (lowest to highest). This variable was also measured in the eighth grade.

**Taking mathematics (TM)**

This is the dependent variable which indicates whether the

*The specific subject self-concept scale was developed by Brookover and associates (1962) to parallel their *Michigan State University General Self-Concept of Academic Ability Scale*. Reliability tests on the general self-concept scale were done using Hoyt's Analysis of Variance. Reliability coefficients between .852 and .865 were found for the six grades tested. The Guttman scalogram analysis was also used to test the general self-concept scale and yielded reproducibility coefficients of .95 and .96 for males and females. The specific self-concept scale items were tested and found to scale in a fashion parallel to the general self-concept scale items. The mathematical self-concept scale was analyzed for reproducibility and was found to have a coefficient above the required .90 (See Brookover, et al., 1967:60, 157-161).*
student completed a course in mathematics in the twelfth grade.

Students who did take mathematics were coded "1," those who did not were coded "0."*

The Questions

The overall focus of this analysis is on the relationship between sex and taking twelfth grade mathematics. However, this effect of sex on taking mathematics may be both direct and indirect. The main focus of this research lies in the indirect effect of sex on completion of twelfth grade mathematics through its impact on parental evaluations of mathematical ability and self-concept of mathematical ability. The questions which this research will deal with are as follows:

1. What is the magnitude of the overall effect of sex on taking twelfth grade mathematics?

2. How is the overall effect of sex on taking mathematics divided into its direct and indirect effects?

3. Controlling for ability (measured IQ), what is the effect of sex on taking twelfth grade mathematics?

*There is some question as to the statistical appropriateness of using a dichotomous dependent variable with regression. Goldberger (1964:248-51) cautions against this in his econometrics text. However, such usage is found in the literature as in Goldberg (1971) where vote (Democrat-Republican) was the dependent variable in his path analysis. Boyle (1971) further supports its use in his discussion of dummy variables in path analysis—the general effect of the violation of the rule is minor.
4. Controlling for social class (SES score), what is the effect of sex on taking twelfth grade mathematics?

5. What is the indirect effect sex has on taking twelfth grade mathematics through its impact on perceived parental evaluations of mathematical ability mediated through self-concept of mathematical ability?

6. What is the indirect effect sex has on taking twelfth grade mathematics through its impact on self-concept of mathematical ability?

The Analysis

In order to answer the above questions, path analysis shall be used along with a number of contingency tables. The first question comparing the two dichotomous variables, sex and taking mathematics, can be answered by examining a cross tabulation of the variables. The second question will be dealt with when the path model is analyzed. The next two questions can be answered by examining three variable tables similar to the table for the first question. Path analysis will show the direct and indirect effects of all five independent variables on the dependent variable, taking mathematics. Hence, answers to the last two questions and the second will be determined here.

The path model used here treats sex, IQ and SES as ultimate variables and PPEMA and SCMA as intermediate variables. The final dependent variable is taking mathematics in the twelfth
grade. The causal ordering of the variables here was partially dictated by their time ordering. The theoretical model further dictated the ordering of perceived evaluations (PPEMA), self-concept (SCMA) and behavior (TM). For further insight into the relationship of these six variables, separate path models for males and females will be compared.

In this analysis, missing data were handled by substituting the mean values of the variables for the missing scores. Of the 558 observations, there were three missing IQ scores, three missing PPEMA responses, and one missing SCMA score.
CHAPTER III

FINDINGS

Introduction

This chapter will present a series of cross-tabulations of sex and taking mathematics with each of the other variables in turn. These are included for descriptive purposes as well as for answering the research questions listed in the previous chapter. Following this, a path analysis of the six variables will be discussed. In addition, separate path models for males and females will be compared.

Sex and Taking Mathematics

In determining the magnitude of the overall effect of sex on taking twelfth grade mathematics, Table 3.1 may be examined.

TABLE 3.1.--Numbers and percentages of males and females who completed twelfth grade mathematics

<table>
<thead>
<tr>
<th>Completed Mathematics Course</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>Yes</td>
<td>53</td>
<td>136</td>
<td>17</td>
</tr>
<tr>
<td>No</td>
<td>47</td>
<td>119</td>
<td>83</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>255</td>
<td>100</td>
</tr>
</tbody>
</table>

45
One third of all students completed mathematics in the twelfth grade, but the separate male and female percentages vary greatly—53 percent of the males completed mathematics while only 17 percent of the females did. This was a ratio of over 3:1 in the males' favor. This overall effect of sex on taking mathematics will be broken into its direct and indirect effects when the path model is examined later in this chapter.

Sex, Ability and Taking Mathematics

In this section, the relationship of the variables sex, IQ and taking mathematics will be examined in relation to the third research question. A comparison of the mean IQ's for males and females can be seen in Table 3.2.

TABLE 3.2.--Mean general intelligence quotient level (IQ) by sex and taking mathematics in the twelfth grade

<table>
<thead>
<tr>
<th>Completed Mathematics</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Yes</td>
<td>115.7</td>
<td>117.3</td>
<td>116.2</td>
</tr>
<tr>
<td>No</td>
<td>108.1</td>
<td>110.3</td>
<td>109.6</td>
</tr>
<tr>
<td>Total</td>
<td>112.2</td>
<td>111.5</td>
<td>111.8</td>
</tr>
</tbody>
</table>

Males had a slightly higher mean IQ than females when all students were compared. When each sex was divided into those who com-
pleted a twelfth grade mathematics course and those who did not, in both comparisons, females had a higher mean IQ than males did. Furthermore, those students who did take mathematics had a higher mean IQ than those who did not, when comparing just males, females, or both together.

In Table 3.3, the students were divided into low, average and high IQ groups.*

TABLE 3.3.--Percentages of males and females who completed twelfth grade mathematics in relation to general intelligence quotient level (IQ)

<table>
<thead>
<tr>
<th>Completed Mathematics Course</th>
<th>Low IQ</th>
<th>Average IQ</th>
<th>High IQ</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
</tr>
<tr>
<td>Yes</td>
<td>36%</td>
<td>11%</td>
<td>53%</td>
</tr>
<tr>
<td>No</td>
<td>64</td>
<td>89</td>
<td>47</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>(Total N)</td>
<td>(84)</td>
<td>(96)</td>
<td>(74)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(97)</td>
</tr>
</tbody>
</table>

When comparing IQ levels within sex, it was evident that more

*The IQ groups used here were based on relative division points with each group being approximately a third of the class. The low IQ group was comprised of students with IQ's less than 107, the average IQ students were those with scores from 107 to 117, and the high IQ students were those with IQ's above 117. Thus, a low IQ student was low in relation to the 558 students studied here, though not necessarily low in the traditional breakdown of IQ where 100 is used as the mean. With this breakdown, males and females were not quite evenly distributed across the
high ability students completed twelfth grade mathematics than did
the low ability students of the same sex. For females, however,
the percentage who took mathematics in the average IQ group was
nearly the same as in the low IQ group; for males, the average
group was more similar to the high IQ group.

The sex differences at each IQ level in the proportion who
took twelfth grade mathematics were striking. The male-female
ratio of the proportions who completed a twelfth grade mathe-
matics course was over 3:1 for low IQ students, over 4:1 for
average IQ students and over 2-1/2:1 for high IQ students. Also,
more low IQ males than high IQ females completed twelfth grade
mathematics, both in absolute numbers and percentagewise.

The gap between the proportions of males and females who
did take mathematics narrowed somewhat when very high IQ males
and females were compared. For students with IQ's of 125 and
above (the top portion of the high IQ category in Table 3.3), 80 per-
cent of the males completed twelfth grade mathematics while only
51 percent of the females did.

Sex, Social Class and Taking Mathematics

This section is similar to the previous one, however, social

three IQ groups. Females were distributed as follows: 32% low
IQ, 38% average IQ and 30% high IQ. The male IQ distribution was
33% low IQ, 29% average IQ and 38% high IQ.
class will be examined here in relation to the other two variables rather than ability. Table 3.4 shows the SES means for males and females.

**TABLE 3.4.**—Mean social class (SES) by sex and taking mathematics in the twelfth grade

<table>
<thead>
<tr>
<th>Completed Mathematics Course</th>
<th>Male $\bar{X}$</th>
<th>Female $\bar{X}$</th>
<th>Total $\bar{X}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>44.7</td>
<td>48.6</td>
<td>45.7</td>
</tr>
<tr>
<td>No</td>
<td>35.3</td>
<td>40.0</td>
<td>38.5</td>
</tr>
<tr>
<td>Total</td>
<td>40.3</td>
<td>41.5</td>
<td>40.9</td>
</tr>
</tbody>
</table>

In comparing these figures, one can note two definite differences in the SES means. First of all, females had higher SES means than males did, when comparing students who took mathematics, those who did not, or all students together. Second, students who completed twelfth grade mathematics had higher SES means than those who did not, whether comparing males, females, or all students.

The 558 students were divided on SES into roughly equal quartiles. *Table 3.5 gives a breakdown of the students by sex

*Here again, this breakdown of SES is not to be viewed as lower class, working class, middle class and upper class. Rather, these SES groups were each roughly a quarter of the class as a whole. The division points for these four categories*
and social class.

TABLE 3.5.--Percentages of males and females who completed twelfth grade mathematics in relation to social class (SES)

<table>
<thead>
<tr>
<th>Completed Mathematics Course</th>
<th>Lowest SES</th>
<th></th>
<th>Second SES</th>
<th></th>
<th>Third SES</th>
<th></th>
<th>Highest SES</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>F</td>
<td>M</td>
<td>F</td>
<td>M</td>
<td>F</td>
<td>M</td>
<td>F</td>
</tr>
<tr>
<td>Yes</td>
<td>42%</td>
<td>14%</td>
<td>47%</td>
<td>11%</td>
<td>56%</td>
<td>16%</td>
<td>69%</td>
<td>23%</td>
</tr>
<tr>
<td>No</td>
<td>58%</td>
<td>86%</td>
<td>53%</td>
<td>89%</td>
<td>44%</td>
<td>84%</td>
<td>31%</td>
<td>77%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

(Total N) (72) (69) (57) (79) (64) (74) (62) (81)

Comparing male SES groups, the proportion who took mathematics increased for each consecutively higher SES group. This was true for females except for the lowest SES group. The difference in the proportions who completed mathematics for any two consecutive SES groups was much larger for males than for females. However, for both sexes, the largest difference was between the third and fourth SES groups.

Comparing males with females at each SES level, a much higher percentage of males than females completed mathematics were as follows: 1st quartile (lowest) 0-20, 2nd quartile 21-38, 3rd quartile 39-60 and 4th quartile (highest) 61-99. The SES distribution for females was 23% in the 1st quartile, 26% in the 2nd, 24% in the 3rd, and 27% in the 4th. For males, this distribution was 28% in the 1st, 22% in the 2nd, 25% in the 3rd, and 24% in the 4th.
in the twelfth grade. The male-female ratios of the proportions who did take mathematics for each SES group were all 3:1 or higher in the males' favor. Further, as with the IQ breakdown, more of the lowest SES males took mathematics than did the highest SES females in absolute numbers and percentagewise.

The above three sections showed the relationship of sex and taking mathematics with ability (measured IQ) and social class (SES). The following two sections will deal with sex and taking twelfth grade mathematics in relation to perceived parental evaluations of mathematical ability and self-concept of mathematical ability. These two variables differ from IQ and SES in that they were intermediate variables rather than control variables. They were actual student responses rather than a type of "background" information on the students.

Sex, Perceived Evaluations and Taking Mathematics

Table 3.6 contains the means for the variable perceived parental evaluations of mathematical ability. It is perhaps not too striking since the means for all categories are so similar. It does indicate, however, that most of the 558 students must have perceived quite high parental evaluations of their mathematical capabilities in the eighth grade, considering the range of possible
TABLE 3.6. --Mean perceived parental evaluation of mathematical ability (PPEMA) by sex and taking mathematics in the twelfth grade

<table>
<thead>
<tr>
<th>Completed Mathematics Course</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>4.6</td>
<td>4.6</td>
<td>4.6</td>
</tr>
<tr>
<td>No</td>
<td>4.3</td>
<td>4.3</td>
<td>4.3</td>
</tr>
<tr>
<td>Total</td>
<td>4.5</td>
<td>4.3</td>
<td>4.4</td>
</tr>
</tbody>
</table>

The overall perceived parental evaluation mean falls between the "above average" and the "among the best" categories. This is probably higher than one might expect for eighth grade students in the area of mathematics.

For males, females and both sexes together, the students who completed the twelfth grade mathematics course had higher PPEMA means than those students who did not, as might be expected. A male-female comparison of perceived evaluation means for those students who did take mathematics, shows that males and females have equal PPEMA means. The same is true for a male-female

*The possible responses to this question were: 1--Among the Poorest, 2--Below Average, 3--Average, 4--Above Average, 5--Among the Best. Since no student responded "Among the Poorest," this category will not be included in the tables in this section.
comparison of students who did not take mathematics. However, what is most important here is the comparison of the means for all males and females. In this case, males as a group did perceive higher parental evaluations of their mathematical ability than did females. This was obscured in the previous two comparisons because so many more males than females completed the twelfth grade mathematics course.

Table 3.7 shows the PPEMA response distribution for males and females. This will probably point out the sex differences in perceived parental evaluations more clearly than the comparison of the PPEMA means in Table 3.6.

TABLE 3.7.--Distribution of perceived parental evaluation of mathematical ability (PPEMA) responses for males and females

<table>
<thead>
<tr>
<th>Perceived Evaluation Response</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td>Below Average</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Average</td>
<td>8</td>
<td>20</td>
</tr>
<tr>
<td>Above Average</td>
<td>33</td>
<td>83</td>
</tr>
<tr>
<td>Among the Best</td>
<td>59</td>
<td>150</td>
</tr>
<tr>
<td>Total</td>
<td>101</td>
<td>255</td>
</tr>
</tbody>
</table>

Comparing all males and females, far more males than females perceived that their parents judged their mathematical capability to be among the best (59% vs. 47%). Females were more likely to
perceive average or above average mathematics evaluations than males. Very few students perceived evaluations of their mathematical ability to be below average.

In Table 3.8 the students were divided into the four perceived evaluation response categories to compare the percents of males and females who completed the twelfth grade mathematics course at each response level.

<table>
<thead>
<tr>
<th>Completed Mathematics Course</th>
<th>Perceived parental evaluation of mathematical ability</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Below Average M</td>
<td>F</td>
<td>Above Average M</td>
<td>F</td>
<td>Among the Best M</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>0% 0%</td>
<td>30% 6%</td>
<td>43% 13%</td>
<td>63% 23%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>100 100</td>
<td>70 94</td>
<td>57 87</td>
<td>37 77</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100 100</td>
<td>100 100</td>
<td>100 100</td>
<td>100 100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Total N)</td>
<td>(2) (5)</td>
<td>(20) (35)</td>
<td>(83) (120)</td>
<td>(150) (143)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

There is a definite relationship between perceived evaluations of mathematical ability and taking mathematics for both males and females. For both sexes, there was a notable increase in the proportion who completed twelfth grade mathematics for each consecutively higher PPEMA-response. The male-female differences were even more striking, however, in the "Average"
category, the male-female ratio of the proportions who completed mathematics was 5:1; in the "Above Average" category it was over 3:1; and in the "Among the Best" category it was also nearly 3:1. In fact, proportionally, there were even more average males taking mathematics than females from the highest evaluation category (30% to 23%). It is also surprising that of the females whose parents considered them to be among the best in mathematics, less than a quarter completed twelfth grade mathematics. There is, of course, a four year difference in the measurement of variables. And these high evaluations may have decreased by the twelfth grade.

Sex, Self-Concept and Taking Mathematics

Table 3.9 shows the self-concept of mathematical ability means for males and females, and for students who completed twelfth grade mathematics and those who did not.

<table>
<thead>
<tr>
<th>Completed Mathematics Course</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>31.4</td>
<td>30.5</td>
<td>31.1</td>
</tr>
<tr>
<td>No</td>
<td>28.2</td>
<td>27.6</td>
<td>27.8</td>
</tr>
<tr>
<td>Total</td>
<td>29.9</td>
<td>28.1</td>
<td>28.9</td>
</tr>
</tbody>
</table>

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Comparing the students who completed twelfth grade mathematics with those who did not, the mathematics students had a higher mean self-concept, when comparing just males, females or both sexes together. Comparing males to females, for all three comparisons, males had a higher mean self-concept of their mathematical ability than females did. The mean SCMA for all males was nearly two points higher than the mean for all females.

The male-female difference in self-concept of mathematical ability is shown more clearly in Table 3.10. The students were divided into three fairly equal self-concept groups.

**TABLE 3.10.**--Distribution of self-concept of mathematical ability (SCMA) responses for males and females

<table>
<thead>
<tr>
<th>Self-Concept</th>
<th>Male</th>
<th></th>
<th>Female</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>N</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td>Low</td>
<td>28</td>
<td>73</td>
<td>39</td>
<td>119</td>
</tr>
<tr>
<td>Average</td>
<td>29</td>
<td>73</td>
<td>33</td>
<td>99</td>
</tr>
<tr>
<td>High</td>
<td>43</td>
<td>109</td>
<td>28</td>
<td>85</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>255</td>
<td>100</td>
<td>303</td>
</tr>
</tbody>
</table>

*The 558 students were divided on self-concept of mathematical ability into three fairly equal self-concept groups using the following division points: Low SCMA--scores less than 27, Average SCMA--scores from 27 to 31, High SCMA--scores greater than 31.
Although males had a higher mean SCMA than females, as shown in Table 3.9, this sex difference in self-concepts is more pronounced in a comparison of the male and female SCMA distributions. Comparing males and females in Table 3.10, proportionally, many more males than females (43% to 28%) judged their mathematical ability to be "high," that is, falling into the top third of the class. The greatest proportion of females (39%) judged their mathematical ability to be "Low," that is, in the lowest third of the class.

Beyond the information in Table 3.10, if one were to look at only the top 20 percent of the class based on self-concept, a male-female comparison would show that the sex difference is still apparent--29 percent of all males judged their mathematical ability to be among the best, while only 17 percent of all females did.

In Table 3.11 the students were again divided into low, average and high self-concept groups to compare the percents who completed twelfth grade mathematics at each self-concept level.

An examination of Table 3.11 shows that self-concept of mathematical ability was related to taking mathematics for both sexes. A greater proportion of high SCMA students completed
twelfth grade mathematics as compared with the average group, and a greater proportion of the average SCMA students took mathematics when compared to the low SCMA group. However, for females, the average group did not differ that much from the low self-concept group. For males, the percentage who completed twelfth grade mathematics in the average group was much more similar to the percentage in the high self-concept group.

TABLE 3.11.--Percentage of males and females who completed twelfth grade mathematics in relation to self-concept of mathematical ability (SCMA)

<table>
<thead>
<tr>
<th>Completed Mathematics Course</th>
<th>Low SCMA</th>
<th>Average SCMA</th>
<th>High SCMA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>F</td>
<td>M</td>
</tr>
<tr>
<td>Yes</td>
<td>34%</td>
<td>11%</td>
<td>56%</td>
</tr>
<tr>
<td>No</td>
<td>66</td>
<td>89</td>
<td>44</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>(Total N)</td>
<td>(73)</td>
<td>(120)</td>
<td>(73)</td>
</tr>
</tbody>
</table>

Comparing males to females, for all three self-concept groups, a much higher proportion of males than females completed twelfth grade mathematics. For those students in the lowest third of the class on SCMA, the male-female ratio of the proportions taking mathematics was 3:1; for the average group, the ratio was 4:1; and for the top third of the class, the ratio was over 2:1.
In fact, proportionally, more low self-concept males completed twelfth grade mathematics than did high self-concept females.

It again seems surprising that only a quarter of the females who judged their mathematical ability to be high actually completed twelfth grade mathematics. Even if one were to look at just the top 20 percent of the class SCMA-wise, which is not shown in Table 3.11, still only 36 percent of these females completed twelfth grade mathematics. But again, these two variables were measured four years apart. These very high self-concept females may have had lower mathematical self-concepts by the twelfth grade.

Path Analysis

In this section the path model for the six variables will be examined in order to look at the direct and indirect effects of the independent variables on taking mathematics. Separate path models for males and females will then be used to compare the effects of the remaining four independent variables on taking mathematics.

Table 3.12 gives the correlation coefficients* from which

*Pearson's product-moment correlation coefficients were used except for correlations involving one of the dichotomous variables, sex or taking mathematics. In this case, the point-biserial correlation coefficient was used. The Phi correlation coefficient was used for correlating the two dichotomous variables.
FIGURE 3.1. -- Path model for all students

*Beta weights are less than twice the coefficient's standard error.
the path coefficients were derived. The multiple correlation coefficient is .486, hence the five independent variables together explain 24 percent of the variance in taking mathematics.

**TABLE 3.12.--Correlation coefficients for the path model for all students**

<table>
<thead>
<tr>
<th></th>
<th>Sex</th>
<th>IQ</th>
<th>SES</th>
<th>PPEMA</th>
<th>SCMA</th>
<th>TM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IQ</td>
<td>-0.027</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SES</td>
<td>0.026</td>
<td>0.226</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PPEMA</td>
<td>-0.116</td>
<td>0.335</td>
<td>0.242</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCMA</td>
<td>-0.158</td>
<td>0.345</td>
<td>0.205</td>
<td>0.712</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>TM</td>
<td>-0.389</td>
<td>0.247</td>
<td>0.153</td>
<td>0.233</td>
<td>0.273</td>
<td>1.000</td>
</tr>
</tbody>
</table>

The model does give somewhat large weights for the error terms and likewise somewhat small path coefficients as might be expected from a simple model as this. The time difference in the measurement of these variables also causes some loss of predictive power. For example, other intervening variables not measured here, such as ninth through twelfth grade parental evaluations of mathematical ability and self-concepts of mathematical ability, together may have explained more of the variance in the variable taking mathematics. In addition to the time difference problem, the model did not include other variables which would, no doubt, be important in the decision-making process such as the instru-
mental and intrinsic value of such a decision. For these reasons, what may appear to be relatively small weights are actually large enough to be substantively as well as statistically significant.

In comparing the direct effects of each independent variable on the dependent variable, the weight of the path from sex to TM was notably heavier than any of the others. This negative weight of -.365 from sex to TM indicates that being female had a direct depressant effect on whether one completed mathematics in the twelfth grade, since males were coded "1" and females were coded "2." This cannot be interpreted as merely one's biological sex being an influencing factor on whether one takes mathematics or not. This variable encompasses a cluster of social factors working against females completing twelfth grade mathematics.

The indirect paths from sex to TM (Sex--PPEMA--TM, Sex--PPEMA--SCMA--TM, Sex--SCMA--TM) followed the same negative direction as the direct effect discussed above. Note first the path from sex to SCMA to TM. Self-concept of mathematical ability in the eighth grade was positively related (.120) to taking mathematics in the twelfth grade. However, sex was somewhat negatively related to SCMA (-.079). Thus, this indirect path would indicate that in addition to the above direct depressant effect which sex had females were somewhat less likely to take
mathematics because of lower self-concepts of their mathematical ability.

There was a stronger indirect depressant effect on the path from sex through PPEMA through SCMA to TM. Here again, there was a positive path from PPEMA to SCMA (.659), and likewise from SCMA to TM (.120). But there was also a negative path from sex to PPEMA (-.113). From this, having higher parental evaluations, one would predictably have a higher self-concept of mathematical ability and would be more likely to take twelfth grade mathematics. But females perceived lower parental mathematical evaluations and, hence, were less likely to take mathematics along this indirect path.

Hence, sex had a depressant effect on taking mathematics both directly and indirectly with the direct path having the heaviest weight. The third indirect path from sex to TM through PPEMA alone was also to females' disadvantage. But this path was not significant because of the relatively small beta weight between PPEMA and TM which was also not twice its standard error.

This would follow the theoretical model in which self-concept is the intervening variable between expectations and behavior rather than expectations having a direct effect on behavior. The data was also in keeping with the theoretical relationship between
expectations of significant others and self-concept of ability—the path weight of .659 from PPEMA to SCMA was the strongest in the path model in Figure 3.1.

IQ and SES both were influential in whether the student completed twelfth grade mathematics or not, both directly and indirectly. Both had their strongest positive weights on their paths to PPEMA and, thus, affected TM indirectly through SCMA. IQ also had a somewhat large weight on its direct path to TM; SES had somewhat less direct effect.

The path model for all students in Figure 3.1 is duplicated in Figures 3.2 and 3.3 for each sex separately, excluding the variable sex. New path coefficients were calculated for the male and female path models. The male and female path models were derived from the correlation coefficients in Table. 3.13. *

**TABLE 3.13.**—Correlation coefficients for the path models for males (below the diagonal) and females (above the diagonal) separately

<table>
<thead>
<tr>
<th></th>
<th>IQ</th>
<th>SES</th>
<th>PPEMA</th>
<th>SCMA</th>
<th>TM</th>
</tr>
</thead>
<tbody>
<tr>
<td>IQ</td>
<td>1.000</td>
<td>.206</td>
<td>.365</td>
<td>.325</td>
<td>.224</td>
</tr>
<tr>
<td>SES</td>
<td>.250</td>
<td>1.000</td>
<td>.248</td>
<td>.196</td>
<td>.143</td>
</tr>
<tr>
<td>PPEMA</td>
<td>.303</td>
<td>.246</td>
<td>1.000</td>
<td>.737</td>
<td>.176</td>
</tr>
<tr>
<td>SCMA</td>
<td>.366</td>
<td>.230</td>
<td>.674</td>
<td>1.000</td>
<td>.190</td>
</tr>
<tr>
<td>TM</td>
<td>.284</td>
<td>.212</td>
<td>.243</td>
<td>.274</td>
<td>1.000</td>
</tr>
</tbody>
</table>

*See the previous footnote in this chapter concerning correlation coefficients.*
FIGURE 3.2. -- Path model for females

*Beta weights are less than twice the coefficient's standard error.
FIGURE 3.3.--Path model for males

*Beta weights are less than twice the coefficient’s standard error.
When sex was removed from the model as an independent variable and separate models for males and females were compared, IQ became the best predictor of taking mathematics (slightly more so for males --- .185 vs. .166). SCMA was also related to TM for both sexes, but again, slightly more so for males than females (.133 vs. .109). And as in the general model, PPEMA affected TM through its indirect path through SCMA rather than directly.

IQ affected SCMA somewhat differently for males and females. For females, IQ affected SCMA indirectly through its effect on PPEMA (.328) rather than directly (.064). For males, although the indirect path from IQ through PPEMA to SCMA was strong (.258), it was less than the IQ-PPEMA path for females. For males, however, the direct path from IQ to SCMA was also strong (.171), which was not so for females.

The most notable difference between the two models was the path weight between PPEMA and SCMA. Parental evaluations were more important in influencing females' self-concept of mathematical ability than they were for males (.712 vs. .613). Parental evaluations were, nevertheless, important for males' self-concept as well.
CHAPTER IV

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary of Findings

The overall findings of this research may be briefly summarized as follows. Being female had a deterrent effect on taking twelfth grade mathematics in an overall sense as well as when controls for ability and social class were introduced. This negative effect for females was both direct and indirect through perceived parental evaluations of mathematical ability and self-concept of mathematical ability. A summary of the specific findings on each of the six major research questions follows.

1. What is the magnitude of the overall effect of sex on taking twelfth grade mathematics?

It was found that many more males than females completed a mathematics course in the twelfth grade. A comparison of the proportions of males and females who did take mathematics shows a ratio of slightly over 3:1 (males - 53%, females - 17%). This well exceeds the 1968 national male-female ratio quoted earlier of 2:1 for high school mathematics classes above the ninth grade. (The students in this study were seniors in 1965-66.)

The cautions noted earlier on male-female comparisons in
high school and beyond should be emphasized again. Because the data included only those students who were in the school system from the seventh through twelfth grades, drop-outs were necessarily excluded. What effect might this have had? The same reasoning might also apply to the other groups of students who were not included in this study—such as those not regularly promoted and those in special education programs. One might reason in the following manner: if more low ability than high ability students drop out of school, then the proportions of males and females completing twelfth grade mathematics in this study should be somewhat higher than comparable proportions from the general population of seventeen year olds. Furthermore, if more males than females drop out of school, especially more low ability males, then the male-female difference in the proportions taking mathematics in this study would probably be larger than the male-female mathematics difference in the general population of seventeen year olds. However, even after considering the above, the sex differences in mathematics found in this study would probably not decrease substantially in the general population.

Furthermore, the population under study included only white students within the school system. Whether blacks took twelfth grade mathematics in a pattern similar to whites remains
an unanswered question.

2. How is the overall effect of sex on taking mathematics divided into its direct and indirect effects?

The overall effect of sex on taking mathematics can be divided into its direct and indirect effects on the dependent variable, completion of twelfth grade mathematics. In order to do this, path analysis was used. When the indirect effects through perceived parental evaluations of mathematical ability and self-concept of mathematical ability were removed, sex still had a heavy direct negative influence on taking mathematics. A negative effect in the context of sex is seen from the female perspective since males were coded "1" and females were coded "2." In fact, the magnitude of this direct effect of sex on completing twelfth grade mathematics was more than twice the magnitude of the next heaviest direct effect (IQ) on taking mathematics. The three possible indirect effects, Sex-PPEMA-TM, Sex-PPEMA-SCMA-TM, and Sex-SCMA-TM, were all negative in their overall effect of sex on taking mathematics. The first of these indirect effects was not theoretically or statistically significant, however. The two remaining indirect effects will be discussed in more detail in subsequent discussion of research questions five and six.

3. Controlling for ability (measured IQ), what is the effect of sex on taking twelfth grade mathematics?
In answering this question, males and females were compared for low, average, and high IQ groups. It was found that for all three IQ levels, a greater proportion of males than females completed twelfth grade mathematics. The male-female ratios of the proportions who did take mathematics were approximately 3:1 for low IQ students, 4:1 for average IQ students and 2-1/2:1 for high IQ students. And surprisingly, more low IQ males completed mathematics than did high IQ females.

It was further found that for both males and females, the percentage of high IQ students who completed twelfth grade mathematics was greater than the percentage of average IQ students who did, which in turn was greater than the percentage of low IQ students who did take mathematics. However, for females there was little difference between the proportions of low and average IQ groups taking mathematics. For males, the average IQ group was more similar to the high IQ group.

4. Controlling for social class (SES score), what is the effect of sex on taking twelfth grade mathematics?

After dividing the class into quartiles by SES, once again, males in each SES group took mathematics at rates roughly three times that of females. Also, nearly twice as many of the lowest SES males took mathematics as compared with the highest SES
For males, the percentage who completed mathematics increased for each SES group (lowest to highest). This was also true for females except for those in the lowest SES group. Furthermore, there was much less difference between consecutive SES groups in the percentage taking mathematics for females than for males. As this might indicate, a comparison of the path models for males and females showed that SES had a greater direct effect on taking mathematics for males than it did for females.

5. What is the indirect effect sex has on taking twelfth grade mathematics through its impact on perceived parental evaluations of mathematical ability (mediated through self-concept of mathematical ability)?

This research question deals with the most important issue in this study—that is, the effect of sex on parental evaluations as they relate to taking mathematics courses. According to the theoretical perspective employed, the perceived expectations of significant others affects one's behavior through their impact on one's self-concept of ability. In this case, perceived parental evaluations of mathematical ability affect the student's decision to take twelfth grade mathematics. The path analysis gave evidence that this relationship did indeed exist. Perceived
evaluations of mathematical ability were very strongly and positively related to self-concept of mathematical ability and this self-concept was positively related to taking mathematics. From this, one could see that perceived parental evaluations influenced students' decisions to take mathematics through their impact on self-concept of mathematical ability. However, sex was negatively related to perceived evaluations; that is, females perceived lower evaluations of mathematical ability than males did. Therefore, sex had a negative indirect effect on taking mathematics through its impact on parental evaluations. This might be interpreted to mean that one of the reasons fewer females elected to take mathematics was because they perceived lower parental evaluations of their mathematical ability and, consequently, had lower self-concepts of their mathematical ability. This, then, was one of the indirect effects of sex on taking mathematics.

The difference between parental evaluations of males and females appeared to be slight when comparing their respective means (4.5 to 4.3). However, a greater difference was apparent when the actual responses were compared. While 59 percent of the males perceived that their parents evaluated their mathematical ability to be among the best, only 47 percent of the females perceived such high evaluations from their parents. Of those students in this "high perceived evaluation" category, nearly
three times as many males as females completed twelfth grade mathematics. This same 3:1 male-female ratio held for the above average students, however, five times as many males as females in the average group chose mathematics.

6. What is the indirect effect of sex on taking twelfth grade mathematics through its impact on self-concept of mathematical ability?

This final research question deals with the second indirect effect of sex on taking mathematics. As mentioned above, self-concept of mathematical ability was positively related to taking mathematics. However, sex was somewhat negatively related to SCMA; that is, females had lower self-concepts. Hence, sex had this negative indirect effect on taking mathematics in addition to the above-mentioned negative indirect effect through perceived parental evaluations of mathematical ability, and the negative direct effect of sex.

Upon examining the tables, further information on the relationship between sex, self-concept of mathematical ability and taking a twelfth grade mathematics course became apparent. Needless to say, at each self-concept level, a much higher proportion of males than females chose mathematics, as the male-female ratio was 3:1 for the low self-concept group, 4:1 for the average group and nearly 2-1/2:1 for the high self-concept group.
For both males and females, the proportion who completed twelfth grade mathematics in the high self-concept group was greater than the proportion who chose mathematics in the average group; this in turn was greater than the corresponding proportion in the low self-concept group. However, for females, the percentage who completed the mathematics course in the average group was nearly the same as for the low group. For males, the average group was much more similar to the high group in the percentage taking mathematics.

It was further found that males rated themselves higher on self-concept of mathematical ability than did females. The difference appeared to be small when comparing the means -- 29.9 for males and 28.1 for females. However, while 43 percent of the males were in the high self-concept group, only 28 percent of the females were. Of the three SCMA groups, the highest percent of the females were in the low self-concept group.

Conclusions and Recommendations

The primary concern of this research was to examine whether fewer females than males completed mathematics in the twelfth grade because females tended to perceive lower parental evaluations of their mathematical ability. This study indicated
that perceived parental evaluations of a student's mathematical ability had a positive effect on whether he or she completed mathematics. When controlling for ability and social class, it was also found that females tended to perceive lower parental evaluations of their mathematical ability than the males did. A similar sex difference was found for the variable self-concept of mathematical ability. Furthermore, perceived evaluations had a stronger effect on self-concept for females than they did for the males. This suggests that perceiving lower mathematical evaluations would be even more harmful to females' predisposition to mathematics as evidenced in their math-taking behavior.

Although sex had the above indirect effect on taking mathematics, it had an even stronger direct impact on completing twelfth grade mathematics. But what latent social factors does the variable "sex" encompass? Are there academic "significant others" besides parents who hold lower mathematical evaluations for females? Other factors have been found to affect the decision-making process, such as the instrumental and intrinsic values attached to the outcome of the decision. Do females attach less instrumental value to taking higher mathematics in high school? Do females see less intrinsic value in studying mathematics? These factors might explain some of the variance
in taking mathematics.

The overriding problem being addressed in this research has to do with why today's adult women are stereotyped as being inferior to men in mathematics. Insofar as taking twelfth grade mathematics reflects whether a person is later considered as being competent in mathematics, one might see some partial justification for such a conclusion (In this study, three times as many males as females completed twelfth grade mathematics.). However, although the stereotype may somewhat reflect the situation as it presently exists, it certainly does injustice to what "reality" could be. This study lends further support to the argument that the social sphere is responsible for male-female differences in mathematics. This suggests the possibility for change or correction. If parents held higher evaluations of their daughters' mathematical ability, and the daughters correctly perceived these evaluations, wouldn't more females choose to take mathematics courses and consequently improve their mathematical ability?

This research leaves many unanswered questions in the area of females and their mathematical abilities which are not reflected in their choice of mathematics courses. Probably one of the most relevant questions is whether the same situation as found with students thirteen years ago still exists in today's high school
students. One might guess that the current emphasis on eliminating sexism in the schools, and in society in general, has altered the situation. However, have outward changes regarding sexism been internalized by teachers, parents and the students themselves? Is there still a far greater proportion of males than females taking mathematics courses? Do parents still evaluate their daughters as having less mathematical ability than their sons? More important, do females continue to perceive lower evaluations of their mathematical abilities? Do females still tend to have lower self-concepts of their mathematical ability as compared to males? One would hope that there has been an improvement in the last thirteen years. Though the expressed ideals may have changed with respect to females and mathematics (which is doubtful in some cases), has reality progressed along with the ideals? This suggests a need for further study.

Another set of unanswered questions are those enumerated previously. Do teachers and peers evaluate females as being less able in mathematics than males? More important, do females perceive lower evaluations of their mathematical ability from teachers and peers. Also, do females attach less intrinsic and instrumental value to studying mathematics? These factors are, no doubt, important in a decision about what courses a student selects in the twelfth grade. Additionally, this study
involved only white students. Are black males and females similar to white students with respect to taking twelfth grade mathematics?

What are the implications of this study? It lends further support to socio-cultural explanations for observed sex differences in mathematics. This study looked at today's twenty-six year olds when they were in high school. It is suggested that the reason today's adult women are considered inferior in mathematics is at least partially due to the fact that fewer women completed twelfth grade mathematics. But going a step further, fewer females than males elected to take higher mathematics in high school at least partially because they tended to perceive lower parental evaluations of their mathematical ability.

If more females are to take higher mathematics, there is a need to improve their self-concepts of their mathematical ability. This might be accomplished through improving the evaluations that parents hold for their daughters' mathematical ability, which has been shown to be effective in improving general academic ability (Johnson, 1970:94-97). If nothing is done, we will continue to hear the age-old adage, that women are not competent in mathematics.
APPENDIX

Michigan State University Self-Concept of Ability in Specific Subjects Scale

1. How do you rate your ability in Mathematics compared with your close friends?
   a. I am the best
   b. I am above average
   c. I am average
   d. I am below average
   e. I am the poorest

2. How do you rate your ability in Mathematics compared with those in your class at school?
   a. I am among the best
   b. I am above average
   c. I am average
   d. I am below average
   e. I am among the poorest

3. Where do you think you would rank in your high school graduating class in Mathematics?
   a. among the best
   b. above average
   c. average
   d. below average
   e. among the poorest

4. Do you think you have the ability to do college work in Mathematics?
   a. yes, definitely
   b. yes, probably
   c. not sure either way
   d. probably not
   e. no

5. Where do you think you would rank in your college class in Mathematics?
   a. among the best
   b. above average
   c. average

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6. How likely do you think it is that you could complete advanced work beyond college in Mathematics?
   a. very likely
   b. somewhat likely
   c. not sure either way
   d. unlikely
   e. most unlikely

7. Forget for a moment how others grade your work. In your own opinion how good do you think your work is in Mathematics?
   a. my work is excellent
   b. my work is good
   c. my work is average
   d. my work is below average
   e. my work is much below average

8. What kind of grades do you think you are capable of getting in Mathematics?
   a. mostly A's
   b. mostly B's
   c. mostly C's
   d. mostly D's
   e. mostly E's
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