To the Graduate Council:

I am submitting herewith a thesis written by Peggy Fuson Hoyal entitled "Sex-Related Differences in Mathematics Achievement and Attitudes among High School Seniors." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Specialist in Education, with a major in Curriculum and Instruction.

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SEX-RELATED DIFFERENCES IN MATHEMATICS ACHIEVEMENT AND ATTITUDES AMONG HIGH SCHOOL SENIORS

A Thesis

Presented for the

Specialist in Education

Degree

The University of Tennessee, Knoxville

Peggy Fuson Hoyal

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ABSTRACT

The purpose of this study was to investigate sex differences in mathematics achievement and attitudes toward mathematics among high school seniors. In addition the study investigated the relationship between mathematics achievement and attitudes among twelfth grade males and the relationship between mathematics achievement and attitudes among twelfth grade females.

Students who participated in the study were seniors in the two high schools of McMinn County, Tennessee, during the school year 1980-81. All seniors were given the opportunity to participate; however, only 51 percent chose to do so by giving permission and responding to the statements on the attitude scales. The scales used to investigate attitudes were the Fennema-Sherman Attitude Scales. Six attitudes which are thought to be related to learning mathematics were measured. Mathematics achievement was assessed by computing the grade point average for each student from semester averages on the student's permanent record.

The attitude scales were administered by home room teachers in March, 1981. Grades were obtained from the permanent records by the researcher after grades for spring semester, 1981, were recorded. Information from students who had completed the same number and kind of mathematics

courses was grouped together, and each group was further divided into male or female. A total of five levels--names for the highest level of mathematics completed--was used. These were General Mathematics, Algebra I, Geometry, Algebra II, and Advanced Mathematics. After subdividing each level into male or female, there were ten groups. The study's four hypotheses were tested by using a one-way analysis of variance, the Wilcoxon Rank Sum Test, and Spearman Rho correlation coefficients.

Tests revealed significant differences on the grade point average in favor of females at the Geometry and Algebra II levels, but no significant differences at the other levels. When comparing attitudes of males and females, there were significant differences in the attitude that mathematics is a male domain at every level except the Algebra II level. Responses of females at all other levels revealed that they thought of mathematics as a subject in which girls can perform as well as boys, but males thought boys do better than girls. Sex differences in responses to each of the other attitudes tested did not reveal enough significant differences to make any conclusions concerning them.

The tests for correlation between grade point average and each of the six attitudes showed these correlations to be significant for females on four of these attitudes at the Geometry level and at the Advanced Mathematics level, on three attitudes at the Algebra I level, and on one attitude at the General Mathematics and Algebra II level females. For males, there were fewer significant correlations between the grade point average and the six attitudes. Correlations were significant for males on three attitudes at the Algebra I level and on one attitude at the Geometry and Advanced Mathematics levels.

In conclusion, the few sex differences in achievement which exist among these seniors favor females. There are few differences in attitudes toward mathematics between the sexes except in considering mathematics as a subject more appropriate for males than for females. These senior males viewed mathematics in this way, but the females did not. Significant relationships between grade point average and attitudes toward mathematics are found frequently among these females but not among the males.

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CHAPTER I

THE STUDY

Until the twentieth century, male intellectual superiority in mathematics was seldom questioned. Burton (1979) quoted Immanuel Kant as an example of this prevailing idea: "All abstract speculations, all knowledge which is dry, must be abandoned to the laborious and solid mind of man. . . . For this reason women will never learn geometry." Research completed during the past decade has indicated that the gap between males and females is narrowing (Fennema and Sherman, 1977). Reasons for this gap have been investigated also (Fennema, 1979; Luchins, 1979). The purpose of this study is to investigate mathematics achievement and attitudes among a sample of high school males and females.

According to 1977-78 National Assessment of Educational Progress (1979) documents, boys outnumber girls 3:2 in senior mathematics classes in high schools of the United States. In the high schools of McMinn County, Tennessee, when considering enrollment in senior mathematics classes for 1979-80, 1980-81, and those students who have enrolled for 1981-82, the ratio of boys to girls is 11:9. This ratio suggests that the enrollment patterns by sex in this county are typical, but the question is raised concerning sex differences in achievement and attitudes of these students.

I. STATEMENT OF THE PROBLEM

The problem of the study was to find out what sex differences there are in attitudes and achievement when comparing students who have completed successfully the same number of courses in mathematics. In addition this study sought to find out if there is a relationship between attitudes and achievement in mathematics among high school males and a relationship between attitudes and achievement in mathematics among high school females.

II. IMPORTANCE OF THE STUDY

Research conducted during the past decade has indicated that, when girls and boys take the same number and kind of mathematics courses, there is little difference in their achievement (Fennema and Sherman, 1977); however, boys take more mathematics courses than girls because they perceive it to be more useful to them and they feel less anxious about their mathematical ability (Fox, 1976). Teachers' attitudes have contributed to the idea that males are better in mathematics than females (Ernest, 1976).

This study was conducted to find out if the trends found in other research hold true in the schools of McMinn County. If they do, the mathematics teachers and guidance counselors need to be aware of this and need to assume responsibility in helping to improve attitudes of all students toward mathematics.

III. ASSUMPTIONS

The following assumptions were made in this study:

1. Students responded truthfully to the items on the attitude scales.

2. Those who completed the attitude scales were typical of the student population of the two high schools in McMinn County.

3. Using the grade point average is a valid method for assessing achievement in mathematics.

IV. DEFINITIONS

Given below are definitions of terms used in this study:

1. Grade point average (GPA) for each student is the arithmetic mean of all semester averages in mathematics for that student. It is a numerical value ranging from 0 to 100 where 75 is a passing grade.

2. Achievement, except in referring to related literature, is the grade point average of the student.

3. Attitudes toward mathematics are those six attitudes measured on the Fennema-Sherman Attitude Scales. Each scale has a score range from 12 to 60.

4. Sex differences are those differences ascribed to a sample of male students or ascribed to a sample of female students.

5. Attitude scale is the Fennema-Sherman Attitude Scale.

V. ORGANIZATION OF THE STUDY

Chapter I has dealt with the problem of the study, its importance, assumptions, and definitions. Chapter II contains a review of the related research and literature. Chapter III explains the design of the study, instrument used, data collection procedures, and analysis of the data. Chapter IV contains the results of the investigation. Chapter V is a summary of the study and its conclusions.

CHAPTER II

A REVIEW OF RELATED LITERATURE

The purpose of this chapter is to review some of the recent literature related to sex differences in mathematics achievement and attitudes. The first section will review literature which concerns itself primarily with sex differences in mathematics achievement. In the second section, literature will be discussed which deals mainly with differences between the sexes in attitudes toward mathematics. The third section will deal with literature which researches the relationship between mathematics achievement and attitudes.

I. LITERATURE ON SEX DIFFERENCES IN MATHEMATICS ACHIEVEMENT

Fennema (1974), in a review of previous research concerning sex differences in mathematics achievement, found that, in most of the research prior to 1960, there were no significant differences in computational tasks, but in reasoning males were better. In a review of three different studies on sex differences (two in 1968, one in 1972), Fennema noted that one study found significant differences in favor of girls at the 10th grade level; one study found significant differences in favor of boys at the 12th grade level; the third study found no significant sex differences at the 9th and 10th grade levels. In a look at 36 studies reported to offer some help in answering the question of sex differences in mathematics achievement, she concluded there were few significant differences through the early high school years. When they did appear, however, they favored boys on higher-level cognitive tasks and girls on lower-level cognitive tasks. Her conclusion at that time was that, on the basis of the research reviewed, more questions were raised than were answered.

A random selection from all high school juniors in the state taking the Washington Pre-College Tests was studied by the Educational Assessment Center at the University of Washington (DeWolf, 1977). When the amount of geometry and algebra taken by the students was controlled, there were no sex differences in quantitative ability but there were for spatial ability. Presumed superiority of males was explained largely by differences in previous coursework. Sex differences found were presumed to be cultural rather than cognitive.

A substantial sex difference in mathematical reasoning ability in favor of boys was found in a study of approximately 10,000 males and females which was conducted through Johns Hopkins University (Benbow and Stanley, 1980). For their evidence, Benbow and Stanley cited the results of six separate Study of Mathematically Precocious Youth talent searches conducted during the past nine years. In a group of 7th and 8th grade students who ranked in at least the upper 5 percent on a standardized achievement test, 43 percent were girls. Both the mathematical and verbal parts of the Scholastic Achievement Test (SAT) were administered to each of these groups. The mathematical section of this test is designed particularly to measure mathematical reasoning ability. Boys and girls did equally well on the verbal portion; however, in mathematics, boys outnumbered girls more than two to one in scores over 500. In a follow-up survey of participants, the mean difference in boys' and girls' scores had increased ten points when they took the SAT again as high school seniors; yet through the junior year an equal proportion (83 percent) of girls and boys had taken mathematics, with no significant difference in grades scored. As a result, the researchers stated that it cannot be concluded that boys' higher scores are a result of their having more formal training in mathematics, but rather that their ability causes them to take more mathematics courses. The reason for this ability was hypothesized to be a combination of internal and external variables and not necessarily due to the difference in socialization processes between the sexes. This is contradictory to the findings of Fennema and Sherman (1977), who found that, when the number and kind of mathematics courses were held constant in high school students, there were few significant differences in mathematics achievement between the sexes.

The NAEP Assessment, 1977-78 (1979), and the Women in Mathematics Survey, Fall, 1978, both deal with samples from the overall population of 13- and 17-year-olds rather than a select group such as the one in the previous study. In the NAEP Assessment, 13-year-old males did slightly better than females on multi-step problems, problems involving graphs, knowledge of measurement, and geometry. Performance was about the same for both sexes on one-step word problems, consumer problems, probability problems, items involving reasoning, knowledge items overall, and mathematics understanding. Females outperformed males on skill items. By age 17 males held an advantage on all parts of the application section, with the greatest difference shown in items about geometry and measurement and non-routine problems. Seventeen-year-old males also had better scores than females on all skill, knowledge, and understanding items. In this study, as in the one done by Benbow and Stanley, course work was found to be about equal for the sexes through Algebra II, and the commission concluded that it is not likely that the differences (3:2 ratio of boys to girls at the senior level) could account for the total performance difference.

Thirteen-year-old girls in the Women in Mathematics Survey (Armstrong, 1980) scored significantly higher than boys on spatial visualization and computation. The two sexes were about equal in algebra and problem-solving. By grade 12, boys scored significantly higher in problem-solving and slightly higher in each of the other three areas. The Sample of the NAEP was a much larger national sample than for this survey, but the results were very nearly equal. In this survey there was a significant difference in the number of males who had taken Algebra II (54 percent versus 42 percent females) and Probability/ Statistics (10 percent versus 5 percent), while there was no difference in the NAEP sample.

Although boys generally do better than girls on standardized tests given by Educational Testing Service (ETS), Casserly of ETS studied 20 high schools in which the two sexes scored equally well in mathematics achievement in the past eight years. These schools had the following features in common:

> . . . the teachers have science, math, or engineering backgrounds rather than backgrounds in education and they communicate a love of and enthusiasm for mathematics. Bright students are grouped together in math classes, the teachers place more than usual emphasis on reasoning, and the teachers counsel students. (Kolata, 1980, p. 1235)

Giesbracht (1980) reported the results of a study of high school students' achievement of selected mathematical competencies which was performed in the province of Saskatchewan. One purpose of the study was to measure the effect of the student's sex on achievement in the areas selected. The random choice of students was made from 161 schools in six school regions and included approximately 3200 students. These represented 5 percent of the students enrolled in each high school grade. Male high school students attained competency on a significantly ($p < .05$) greater number of mathematical skills than did females after adjustments were made for intelligence. Giesbrecht concluded by pointing out the two current theories concerning the problem of sex differences favoring males over females in mathematics: social conditioning and differences in the brain of males and females.

Luchins (1981) reported that, in a survey of over 100 general psychology texts covering the years 1875-1975, the sex differences most frequently cited, after greater physical strength for men, were greater spatial ability in males (91 percent of texts) and greater verbal ability in females (83 percent of texts). From a 1977 psychology text she found evidence that spatial ability has an innate--and inheritable--component. From further research Luchins found this conclusion unacceptable and was concerned by the fact that mathematicians and educators accept the assumed sex differences in brain functioning and use different methods for teaching males and females.

> Such proposals seemingly overlook that the alleged sex differences in cortical functioning are not firmly established and that their relationships to spatial, verbal, and mathematical abilities . . . are not clear. (p. 416)

On the basis of studies performed on high school students to test recognition of geometric solids from descriptions, she concluded that methods of teaching mathematics may cause greater variations in learning than sex differences.

II. LITERATURE ON SEX DIFFERENCES IN ATTITUDES TOWARD MATHEMATICS

Ernest (1976), under the auspices of the mathematics department of the University of California at Santa Barbara, examined sex differences in attitudes toward mathematics of students through grade 12, attitudes of their teachers, and sex differences in the extent of mathematics training in high school. A sample of 1324 questionnaires including approximately 100 from each grade level (2 through 12) revealed that mathematics is equally appealing to both sexes through grade 8; yet, when it becomes an optional subject in high school, far fewer women than men take it. The conjecture was that high school males take mathematics more than females because they consider it necessary training for the future occupations they hope to enter. By grade 9, both sexes thought boys were superior to girls in mathematics. When asked why they made a poor grade in a subject, most students gave lack of effort as the reason. When the subject was mathematics, 26 percent of females, compared to 15 percent of males, gave lack of ability as the reason. From a small sampling of teachers (24 women and 3 men) who rated mathematics as a subject they liked to teach, responses to questions concerning students' abilities revealed that 41 percent felt that boys did better in mathematics while no one felt girls did better.

Fox (1976), in a review of studies on how women viewed mathematics as related to their careers, found that girls with high ability in mathematics experience conflict in career interests. This conflict results from their underlying values being inconsistent with their intellectual talents. Girls who take advanced mathematics courses are "those who receive encouragement from parents, guidance counselors, mathematics teachers, and peers" (p. 348). Fox saw the role of teachers of mathematics as important in fostering greater interest in mathematics among girls and in working with counselors to create special career counseling programs which emphasize how important mathematics courses are as background for a variety of careers for both sexes.

Luchins (1979) told of a study she did for the National Science Foundation in which questionnaires were sent to all members of the Association for Women in Mathematics. Replies were received from only about 40 percent of the membership (350 females and 52 males). The response to two questions is noted here: (1) What people discouraged your decision to be a mathematician? "Teachers" as a response was checked by 21 percent of females and 8 percent of males. (2) At the pre-college level, were you treated differently as a math student because of being female (male)? Among females, 23 percent replied "yes"; among males, 6 percent replied in the affirmative. Typical comments included: "My teacher paid attention only to the boys." "My counselor said girls didn't do well in math."

In his study of attitudes toward mathematics, Norman (1977) found that females had poorer attitudes toward mathematics from grade 9 on. This cross-sectional study, done in grades 2, 6, 7, 8, 9, and 10, among students in Albuquerque, New Mexico, found no differences in attitudes until grade 6. Beginning with grade 6, males had better attitudes toward mathematics, but it was insignificant until grade 9. Males had better mathematics reasoning after the age of 13. Statements such as "I like mathematics because it is practical" and "I'm afraid of doing word problems" revealed significant differences ($p < .01$) in favor of males in attitudes of males and females after grade 8. Explanation of these attitudinal differences, according to Norman, lies in sex-role development, which is influenced in large measure by parents and teachers.

In her book, <u>Overcoming Math Anxiety</u>, Tobias (1978), in discussing the nature of mathematics anxiety, explored some common myths concerning mathematical ability. One myth, peculiar to mathematics, is that people either have or do not have a mathematical mind. Teachers and parents contribute to this myth. Tobias also explored fears surrounding mathematics--one of which is fear of being too dumb or too smart. Since many people view mathematical ability as unfeminine, to appear too smart may ruin a female's social life. Fear of appearing too dumb may be worse, though, since this will keep a student from asking questions necessary to go on with the course. From Tobias' studies of mathematics anxiety she concluded that it is felt by both men and women but is more disabling to women.

III. LITERATURE ON THE RELATIONSHIP BETWEEN ACHIEVEMENT IN AND ATTITUDES TOWARD MATHEMATICS

A cross-sectional study was done by Fennema and Sherman (1978), using 1320 students in grades 6 through 8 in the Madison, Wisconsin schools. These students were in feeder schools for the four high schools used in another Fennema and Sherman study. In both studies, two cognitive and eight affective variables were studied. Fennema-Sherman Attitude Scales were used for the affective variables, while a standardized achievement test was used to study the cognitive ones. Results of these tests were combined with the results of the high school study. For the cognitive variables it was concluded that, in grades 6-12, sex-related differences in mathematics do not appear often and, when they do, are not large. Differences did not increase with more complex levels of mathematics.

Study of the affective variables revealed that, as early as grade 6, girls express less confidence than boys in their ability to do mathematics; the subject is clearly sex-typed male, especially by the boys. In high school more negative attitudinal influences occur. For example, girls feel mathematics is less useful to them and perceive less favorable attitudes on the part of their teachers and parents, especially fathers. This contributes to a decline in enrollment of girls in mathematics classes, beginning in grade 10. Further study is needed, according to the researchers, into which factors within a school milieu might have negative effects on girls with respect to mathematics learning.

Two longitudinal studies dealt with mathematics achievement as it relates to attitude toward mathematics. In 1960, Anttonen (1969) tested 1017 students in the 5th and 6th grades from a school district in St. Paul, Minnesota, with a mathematics attitude scale. In the spring of 1966, 776 of these students were still enrolled in this district, but, for various reasons, only 607 of these--now high school juniors and seniors--were tested with a similar attitude scale. Test results from standardized Iowa tests were used for mathematics achievement scores both years. A mathematics grade-point average was calculated for each student from courses taken from junior high to senior high school. All these results were tabulated by sex, but the results were inconclusive. The only significant difference in the breakdown by sex was the correlation between the achievement test score and elementary attitude score, which was much lower for girls than for boys. The correlation between elementary attitude scores and elementary and secondary mathematics achievement indicated that prediction of mathematics achievement for either sex on the basis of a

5th and 6th grade attitude instrument is risky. Better predictions can be made at the high school level.

The other longitudinal study, by Hilton and Berglund (1974), was part of a Growth Study begun at ETS in 1961. Its purpose was to pursue the hypothesis of sex-type interests. The Sequential Test of Educational Progress and the School and College Ability Test were given in 1961 to a nationwide sample of 5th graders and then in 1963, 1965, and 1967, to 7th, 9th, and 11th grades, respectively. Holding the amount of mathematics training constant for the sample, students were picked who had three or four mathematics courses in grades 7-10. At the high school level, boys enrolled in more mathematics courses than girls. Attitudes were revealed by answers to items on the Background and Experience Questionnaire. One hypothesis was that differences in mathematics achievement between the sexes would begin at adolescence and would widen thereafter in concert with widening differences in interest between the sexes. The results of the study were consistent with this. Greater achievement results from greater interest and conversely. One word of encouragement from a teacher (so the researchers said) may increase interest and performance. A close relationship exists between a student's perception of mathematics and his performance in it. Physiological and psychoanalytical explanations for disparity in mathematics achievement between the sexes are unwarranted.

Brocklehurst (1979), in a review report concerning mathematics avoidance by women, explained that mathematics avoidance was a symptom of mathematics anxiety. The effect of this avoidance shows up in the 50-point lead of the average score of men over that of women on the mathematical portion of the SAT. The Advisory Panel on the SAT Score Decline attributed this difference to the "traditional sex-stereotyping of career opportunities and expectations." Brocklehurst stated that by puberty mathematics is considered a male domain in students' minds, and girls suffer increasing lack of confidence in the subject. She concluded her report by emphasizing that it is important for educators to realize and emphasize that a strong background in mathematics is needed for women to pursue many careers and for them to encourage women to persist in mathematics.

In a review of research of the 70's with respect to equity for women in mathematics education, Fennema (1979) pointed out that, even though males continued to dominate mathematics-related occupations, the 70's research resulted in a re-examination of sex-related differences and a deeper look at explanations related to any difference. Sex-related differences in high school mathematics learning in 1976 were not as great as earlier. When the amount of mathematics studied was controlled, few significant differences were found in achievement between males and females. There was a large difference in the ratio of each sex enrolled in high school mathematics classes, but when the amount and quality of time spent learning mathematics were equal, differences in performance disappeared.

Some of the variables which were thought to exert a major influence were examined. In cognitive factors, there were no conclusive findings of male superiority. Several affective variables were thought to influence women's mathematics education. By the 12th grade, females considered mathematics as a male domain; high anxiety was associated with low achievement in mathematics; high confidence was more highly correlated with mathematics achievement than any other affective variable ($r = 0.40$); mathematics was not perceived by females to be as useful to them as to males. As for education as a variable, teachers are an important influence. Traditionally, teachers have encouraged boys to be more independent and girls to be more dependent. In traditional schools, boys are the leaders and girls the followers in problem-solving. Fennema suggests that an intervention program is needed to insure more female participation in mathematics.

CHAPTER III

DESIGN AND PROCEDURE

The purpose of this chapter is to discuss the design of the study, the Fennema-Sherman Attitude Scales, the use of the grade point average, data collection procedures, and analysis of the data.

I. DESIGN OF THE STUDY

Students involved in this study were seniors at the two high schools in McMinn County, Tennessee, during the school year 1980-81. The population in this county is small town (12,000 or less) or rural in nature. There were 296 seniors at McMinn County High School (McMinn)--147 boys and 149 girls. At Central High School of McMinn County (Central), there were 199 seniors--108 boys, 91 girls. Of this number, 43 boys from McMinn (29 percent), 102 girls from McMinn (68 percent), 60 boys from Central (56 percent), and 47 girls from Central (52 percent) completed the attitude scales. For all high school seniors in the county, this constituted a 51 percent response level.

The study was designed to test the following hypotheses:

H_1: When comparing those students who have taken the same number of mathematics courses, there are no significant sex differences in achievement in mathematics among the high school seniors in McMinn County.

H_2: When comparing those students who have taken the same number of mathematics courses, there are no significant sex differences in attitudes toward mathematics among the high school seniors in McMinn County.

H_3: There are no significant relationships between attitudes and achievement in mathematics among the female seniors in McMinn County.

H_4: There are no significant relationships between attitudes and achievement in mathematics among the male seniors in McMinn County.

II. FENNEMA-SHERMAN ATTITUDE SCALES

The Fennema-Sherman Attitude Scales (Fennema-Sherman, 1976) consist of nine "domain specific Likert-type scales." Each scale has been hypothesized to be related to learning mathematics. Six of these have been used in this study.

The Mathematics as a Male Domain Scale (Male Domain) measures the degree to which students perceive mathematics as a subject in which males have more ability and perform better than females. On this test a high score means the student thinks the two sexes perform equally well. A lower score is attached to a feeling of male superiority. The Mathematics Anxiety Scale (Anxiety) is intended to measure feelings of dread, nervousness, and anxiety related to doing mathematics. The higher the score, the more at ease one is with mathematics. Confidence in one's ability in mathematical tasks is measured by the Confidence in Learning

Scale (Confidence). Students' beliefs concerning how useful mathematics is or will be in their future education or vocation is measured by the Mathematics Usefulness Scale (Usefulness). Designed to measure students' perception of their teachers' attitudes toward them as learners of mathematics, the Teacher Scale (Teacher) includes interest, encouragement, and confidence in the student's ability as displayed by the teacher. Effectance motivation is similar to a problem-solving attitude, thus the Effectance Motivation Scale (Effectance) is intended to measure an intrinsic joy in the challenge of mathematics problems.

Appendix A contains these six attitude scales. Each scale contains six positively worded and six negatively worded items with five possible choices per item: strongly agree, agree, undecided, disagree, and strongly disagree. The weight of five is given to the item hypothesized to have a positive effect on learning mathematics. On the Male Domain scale, this is considered to be a lack of stereotyping mathematics as a male subject. Student scores on each test range from 12 through 60. Split-half reliabilities for the scales range from .87 on the Male Domain and Effectance scales to .93 on the Confidence scale (Fennema-Sherman, 1976, p. 14).

III. THE USE OF GRADE POINT AVERAGE

Since no standardized tests are given to all students at both schools during the senior year, the only measure of achievement used was the grade point average (GPA). Both schools use a numerical system of grading with 75 considered a passing grade. Grades in the 95-100 range are the equivalent of an "A" letter grade. The GPA for each student was computed by finding the arithmetic mean of all semester averages in mathematics, whether passing or failing, listed on the student's permanent record.

One year of mathematics is required of all students for high school graduation. A credit in General Mathematics, Pre-Algebra, or Algebra I meets this requirement. Courses counted as mathematics courses were General Mathematics, Pre-Algebra, Algebra I, Geometry, Algebra II, and Advanced Mathematics. Although Business Mathematics is taught in both schools, it is classified as a business course and was not counted.

IV. DATA COLLECTION PROCEDURES

At the beginning of the school year 1980-81, permission to use students in the McMinn County schools was granted by Bruce Jordan, superintendent of McMinn County schools. Approval for using human subjects was obtained from the human subjects committee of the University of Tennessee, Knoxville, in September, 1980.

In March, 1981, all seniors were given letters to sign for their permission to participate in the study or parental permission if the students were under 18 (see Appendix B). As suggested by the authors of the attitude scales, all 72 items were randomly distributed into one instrument, using a table of random numbers (see Appendix C).

V. DATA ANALYSIS

Grade point averages for each student were computed by the researcher, using the information from each student's permanent record card. The six attitude scales were scored by the researcher also. Statistical analysis of the data was performed at the University of Tennessee Computing Center.

The following five categories were used to compute means and standard deviations for each of the seven variables by sex:

General Mathematics (Gen. Math.): Students who have made a passing grade (75 or above) in only one year of high school mathematics--either General Mathematies or Pre-Algebra.

Algebra I (Alg. I): Students who have passed Algebra I but have completed no further mathematics courses.

Geometry: Students who have passed Algebra I and Geometry but have completed no further mathematics courses.

Algebra II (Alg. II): Students who have passed Algebra I, Geometry, and Algebra II but do not have a credit in Advanced Mathematics.

Advanced Mathematics (Adv. Math.): Students who have passed Algebra I, Geometry, Algebra II, and Advanced Mathematics.

For each of the seven variables on which data were collected, the means and standard deviations for males in each of the five categories of students were computed. In order to test hypothesis 1, a one-way analysis of variance was computed, which is the equivalent of a t-test. Since the data for the attitude scales were not considered to be interval or ratio, the Wilcoxon Rank Sum Test was used to test hypothesis 2. On this test, $|Z| > 1.96$ is significant at the .05 level; $|Z| > 2.58$ is significant at the .01 level. Hypotheses 3 and 4 were tested for each group by using Spearman Rho Coefficients of Correlation.

CHAPTER IV

RESULTS OF THE STUDY

The purpose of this chapter is to present and discuss the statistical analysis of the data.

I. RESULTS OF TESTS FOR SEX DIFFERENCES

Tables 1, 2, and 3 show the means and standard deviations for each variable considered. At every level except Alg. I, the GPA for females is higher than that for males; however, the differences are significant at Geometry and Alg. II levels only.

On the attitude scales, the higher score indicates a more positive attitude toward mathematics. A score of 36 would indicate a neutral attitude. On the Male Domain scale, the higher the score the lower is one's perception that mathematics is a subject in which males should do better than females. On this scale females scored higher than males at every level. The differences were significant for all levels except Alg. II.

Low anxiety yields a high score on the Anxiety scale; high confidence yields a high score on the Confidence scale. Table 2 indicates that all levels of males have scores indicating at least slightly above neutral on Anxiety, while only at Alg. II and Adv. Math. levels do females show this. Confidence follows a pattern similar to that of Anxiety.

TABLE 1

MEANS AND STANDARD DEVIATIONS FOR GRADE POINT AVERAGE OF HIGH SCHOOL SENIORS IN MCMINN COUNTY

Level	Sex	n	$\bar{X}$	SD
General Mathematics	Female	36	80.61	7.32
	Male	30	80.50	6.76
Algebra I	Female	43	81.44	5.97
	Male	27	82.91	7.09
Geometry	Female	23	86.25**	4.87
	Male	14	80.59	5.97
Algebra II	Female	20	89.02*	5.11
	Male	20	84.81	5.01
Advanced Mathematics	Female	27	92.14	4.30
	Male	12	90.58	5.26

Significance found for differences between males and females on ANOVA. See Table 5, Appendix D.

*Significant at .05 level.

**Significant at .01 level.

TABLE 2

MEANS AND STANDARD DEVIATIONS FOR SCORES OF HIGH SCHOOL SENIORS IN MCMINN COUNTY ON THE FENNEMA-SHERMAN ATTITUDE SCALES: MALE DOMAIN, ANXIETY, CONFIDENCE

			Male Domain		Anxiety		Confidence	
Level	Sex	n	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Gen. Math.	Female	36	49.36**	6.41	33.22	8.96	32.86	10.29
	Male	30	40.47	7.76	36.13	6.62	35.80	6.33
Alg. I	Female	43	52.14**	5.06	32.91	10.53	32.86	10.44
	Male	27	40.96	7.08	37.33*	7.24	38.78*	8.22
Geometry	Female	23	53.00**	5.17	35.43	11.97	39.04	11.18
	Male	14	44.79	9.46	37.50	5.68	38.07	7.34
Alg. II	Female	20	53.90	4.58	38.45	10.21	43.10	9.39
	Male	20	49.40	7.25	40.60	9.65	42.35	7.65
Adv. Math.	Female	27	52.48**	5.04	45.07	6.73	47.22	5.78
	Male	12	42.75	5.31	45.25	6.70	46.42	8.72

Significance found for differences between males and females on the Wilcoxon Rank Sum Test. See Table 6, Appendix D.

*Significant at .05 level.

**Significant at .01 level.

TABLE 3

MEANS AND STANDARD DEVIATIONS FOR SCORES OF HIGH SCHOOL SENIORS IN MCMINN COUNTY ON THE FENNEMA-SHERMAN ATTITUDE SCALES: USEFULNESS, TEACHER, EFFECTANCE

Level	Sex	n	Usefulness		Teacher		Effectance	
			$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Gen. Math.	Female	36	39.75	7.54	35.17	6.80	33.56	8.01
	Male	30	40.00	5.92	36.73	5.58	33.00	4.64
Alg. I	Female	43	41.33	8.16	37.54	8.49	36.14	10.20
	Male	27	40.93	6.86	35.63	7.19	34.70	7.55
Geometry	Female	23	42.61	7.87	39.70	8.58	36.35	8.69
	Male	14	44.21	8.02	39.64	6.43	38.71	5.94
Alg. II	Female	20	45.55	8.64	43.60	8.39	38.60	9.00
	Male	20	48.75	6.22	40.95	6.35	39.50	6.38
Adv. Math.	Female	27	51.11	6.22	47.52*	6.71	43.15	9.93
	Male	12	48.25	6.00	43.08	6.61	41.17	9.33

Significance found for differences between males and females on the Wilcoxon Rank Sum Test. See Table 6, Appendix D.

*Significant at .05 level.

Only students at Gen. Math. level and females in Alg. I level have low confidence. The confidence level increases in both sexes as the amount of mathematics taken increases. Exceptions to this are found in females from Gen. Math. to Alg. I, where the mean remained the same, and in males from Alg. I to Geometry, where the mean showed a small decrease. Only at Alg. I level are the differences between the attitudes of males and females significant on either the Anxiety scale or the Confidence scale. At this level the males show lower anxiety and higher confidence at the 5 percent level of significance.

Both sexes perceived mathematics to be a useful subject, with the attitude toward usefulness improving as the number of mathematics courses taken increased. Exception to this is noted between Alg. II and Adv. Math. level males, where the score decreased slightly. No significant differences between males and females appear on the Usefulness scale.

Attitude of the teacher toward the student showed more effect on girls than boys at every level except Gen. Math. Teacher attitude was significant, however, only at Adv. Math. level. At no level was this attitude very much above neutral for either sex except Adv. Math. females.

Effectance motivation, or intrinsic motivation for problem-solving, increased slightly as the level of mathematics taken increased, but a high positive attitude was not shown at any level. There were no significant differences between the sexes on this attitude.

II. RESULTS OF TESTS FOR RELATIONSHIP BETWEEN ACHIEVEMENT AND ATTITUDES

Spearman Rho Coefficients of Correlation were computed to compare the GPA with each of the other variables. Table 4 shows the values of each correlation. For females, there is a significant correlation between GPA and the Teacher scale at every level except Gen. Math. GPA and Anxiety in females show a significant correlation at Gen. Math., Geometry, and Adv. Math. levels. Significant correlation between GPA and Confidence is seen for females in Alg. I, Geometry, and Adv. Math. level. In Alg. I level females there is a high correlation between GPA and Male Domain; Effectance and GPA are correlated significantly in Adv. Math. level females; Geometry level females' answers reveal a significant correlation between GPA and Usefulness. In males the correlations of significance are: GPA and Teacher at Alg. I and Geometry levels; Anxiety and GPA at Alg. I and Adv. Math. levels; GPA and Effectance at Alg. I level.

TABLE 4

SPEARMAN RHO COEFFICIENTS OF CORRELATION FOR GRADE POINT AVERAGE AND VARIABLES ON FENNEMA-SHERMAN ATTITUDE SCALES FOR HIGH SCHOOL SENIORS IN MCMINN COUNTY

Level	Sex	Male Domain	Anxiety	Confidence	Usefulness	Teacher	Effectance
Gen. Math	Female	.201	.362*	.328	-.070	.288	.245
	Male	.022	.012	.193	-.052	-.079	-.243
Alg. I	Female	.542**	.276	.380*	.229	.345*	.160
	Male	-.148	.498**	.291	.150	.383*	.399*
Geometry	Female	-.249	.489*	.477*	.532**	.642**	.381
	Male	.529	.043	.176	.497	.551*	-.196
Alg. II	Female	.205	.038	.380	.210	.493*	.147
	Male	-.427	.424	.192	-.260	-.171	-.079
Adv. Math.	Female	.166	.621**	.683**	.155	.584**	.568**
	Male	-.039	.625*	.312	.132	-.114	.407

*Significant at .05 level.

**Significant at .01 level.

CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS AND IMPLICATIONS

The purpose of this chapter is to summarize the study, state its findings, and discuss conclusions and implications for future use.

I. SUMMARY

This study was designed to investigate sex differences in mathematics achievement and attitudes toward mathematics, and to investigate relationships between achievement in mathematics and attitudes toward mathematics. All subjects involved in the study were seniors in the high schools of McMinn County, Tennessee, a county whose population classifies it as small town/rural. Subjects were divided into five groups based on the number of mathematics courses they completed in high school and, if they completed only the required one year, whether this was General Mathematics or Algebra I. Data collected from 36 females and 30 males who completed the one-year requirement in General Mathematics, 43 females and 27 males who had the one-year requirement in Algebra I, 23 females and 14 males who completed two years--Algebra I and Geometry, 20 females and 20 males who completed three years--through Algebra II, 27 females and 12 males who completed all four years of mathematics were included in this study. The data consisted of seven variables--one cognitive and six affective.

The six affective variables--attitudes toward mathematics--were measured by the Fennema-Sherman Attitude Scales; the cognitive variable--achievement in mathematics--was measured by the grade point average of each student computed from information on the permanent record cards.

It was hypothesized that:

H_1: When comparing those students who have taken the same number of mathematics courses, there are no sex differences in achievement in mathematics among the high school seniors in McMinn County.

H_2: When comparing those students who have taken the same number of mathematics courses, there are no sex differences in attitudes toward mathematics among the high school seniors in McMinn County.

H_3: There are no relationships between attitudes and achievement in mathematics among the female seniors in McMinn County.

H_4: There are no relationships between attitudes and achievement in mathematics among the male seniors in McMinn County.

Scoring of the attitude scale as well as finding the mean GPA was done by the researcher. Statistical analysis of the data was performed by the University of Tennessee Computing Center. Hypothesis 1 was tested by a one-way analysis of variance (ANOVA). Hypothesis 2 was tested by using the Wilcoxon Rank Sum Test. In hypotheses 3 and 4, the Spearman Rho correlation coefficients were tested for significance at the .05 level. These correlation coefficients were measures of the relationships between mathematics achievement and each of the six attitudes for males and females.

II. FINDINGS

The findings of the study with relation to the hypotheses were as follows:

1. Since there were significant differences between females and males in GPA at the levels of Geometry and Alg. II, hypothesis 1 was rejected at these levels. Hypothesis 1 was not rejected for differences in Gen. Math., Alg. I, and Adv. Math.

2. Hypothesis 2 was not rejected at any level for the Usefulness scale and the Effectance scale. Females showed a higher anxiety at every level. The difference was significant for Alg. I level only. Hence, hypothesis 2 was rejected at the Alg. I level for the Anxiety scale but was not rejected at the other levels. Confidence was significantly higher for males than for females at the Alg. I level. As a result, hypothesis 2 was rejected at the Alg. I level for the Confidence scale but was not rejected at the other levels. Girls were affected more positively than boys by teachers' attitudes toward them, but this difference was significant at the Adv. Math. level only; thus, hypothesis 2 was rejected for the Teacher scale at the Adv. Math level but was not rejected at other levels. Males

considered mathematics to be a male domain to a much greater degree than females did. Every level participating except the Alg. II level showed a significant difference between males and females on this attitude. Hypothesis 2 was rejected for Gen. Math., Alg. I, Geometry, and Adv. Math. but was not rejected for Alg. II.

3. At the Alg. I level, there was a significant correlation between GPA and Male Domain. Hypothesis 3 was rejected at this level but was not rejected at the other levels for this relationship. When comparing GPA with the Anxiety scale, a significant correlation was found at the Gen. Math., Geometry, and Adv. Math. levels. Hypothesis 3 was rejected at these three levels but not rejected for Alg. I and Alg. II. The correlation of the Confidence scale with GPA was signficant at Alg. I, Geometry, and Adv. Math. levels. Hypothesis 3 was rejected for these levels but not rejected for Gen. Math. and Alg. II. There was a significant correlation on the Usefulness-GPA relationship for the Geometry level females; hence, hypothesis 3 was rejected at this level but was not rejected at the other four levels. Hypothesis 3 was rejected at every level except Gen. Math. for the GPA-Teacher relationship, since at all other levels the correlations were significant for females. In comparing the Effectance scale with GPA, hypothesis 3 was not rejected at any level except Adv. Math. It was rejected for Adv. Math because of the significant correlation shown at this level.

4. Hypothesis 4 was not rejected at any level for GPA and Male Domain, GPA and Confidence, and GPA and Usefulness, since there were no significant correlations for these three relationships. There were no significant differences at the Alg. I and Adv. Math. levels for the GPA-Anxiety relationship. Hypothesis 4 was rejected at these levels but was not rejected for Gen. Math., Geometry, and Alg. II levels. The GPA-Teacher relationship was signficant at the Alg. I and Geometry levels; thus, hypothesis 4 was rejected at these levels but not rejected for Gen. Math., Alg. II, and Adv. Math. for this relationship. Effectance-GPA correlation was signficant for Alg. I level males but for no other level; hence, hypothesis 4 was rejected at this level but not rejected for Gen. Math., Geometry, Alg. II, and Adv. Math. males.

III. OTHER OBSERVATIONS

A study of the means on each scale for various levels of mathematics taken revealed the following information:

1. Students at all levels of both sexes scored in the neutral range on the Effectance scale. Examples of statements on this scale are: "Mathematics is enjoyable and stimulating to me" and "Math puzzles are boring." Responses indicated a lack of intrinsic motivation in mathematics among these students.

2. Responses to statements on the Teacher scale indicated that the prevailing student attitude for both sexes

except for the Adv. Math. level is close to a neutral attitude toward the teacher as an influence in learning mathematics.

3. Responses on the Anxiety and Confidence scales, except for the Adv. Math. level, were close to neutral. The lowest medians of any score were found on these two scales. Scores of 32.91 on Anxiety and 32.86 on Confidence were scored by Alg. I level females.

4. As the number of mathematics courses taken by students increased, scores increased for both sexes on the attitude scales as well as the GPA. Out of 56 possible changes as the level changed, seven showed a decrease in score as the level of mathematics increased; one remained the same; the other 48 showed an increase.

IV. CONCLUSIONS AND IMPLICATIONS

With respect to the hypotheses of this study, the following conclusions were made:

1. Since sex differences in GPA are not significant except at Alg. II and Geometry levels, and at these two levels the girls have the higher GPA, the view (Fennema and Sherman, 1977) that sex differences in performance in high school mathematics classes are minimal is upheld by this study. Enrollment in senior mathematics classes was the same for males and females in 1980-81; yet, when the three years, 1979-82, are combined, boys outnumber girls 11:9--a ratio closer to the 3:2 ratio found in the NAEP

(1979) report. For 1980-81, 13 percent of male seniors and 13 percent of female seniors were enrolled in Advanced Mathematics in McMinn County, compared to 5 percent and 3 percent for the 1977-78 NAEP (1979) sample.

2. That females view mathematics as a study in which they can perform as well as males is perhaps the most important finding of this study. Because peer influence is important among this age group, teachers, counselors, and even the community should assume responsibility to help males to see mathematics as a subject which is useful for females as well as for themselves.

3. There is no pattern for sex differences in each of the other attitudes; therefore, no conclusions can be made concerning these.

4. As for relationships between GPA and the various attitude scales, these appeared to be more important among the females than among the males. Of the 30 correlations shown for females, 13 were significant. At the Geometry and Adv. Math. levels, four correlations were significant; three were significant at the Alg. I level; one each at the Gen. Math. and Alg. II level females. For the males, five of the 30 correlations were significant. There were significant correlations on three attitude-GPA comparisons at the Alg. I level, one at the Geometry level, and one at the Adv. Math. level. This suggests that attitudes toward mathematics affect girls' grades in high school more than they affect boys' grades.

5. Every attitude showed significant correlation with the GPA for at least one level for females, but the attitude which correlated with GPA most often for males as well as females was the Teacher attitude. This suggests that perceiving a favorable attitude on the part of the teacher toward students as learners of mathematics helps students improve their grades.

6. Anxiety correlated significantly with GPA in five of the ten groups of students. Ways to alleviate anxiety over mathematics for both sexes should be considered in order to improve achievement. From studying the Confidence-GPA correlation one might conclude that improving females' confidence in their ability--closely related to reducing anxiety--could help them improve their grades.

Other conclusions and implications are made as follows:

1. Efforts should be made by teachers in this county to provide greater encouragement for students to study mathematics. Responses to statements on the Teacher scale indicate that the prevailing student attitudes for both sexes except for the Adv. Math. level is close to a neutral attitude toward the teacher as an influence in learning mathematics.

2. Administrators should provide in-service education for teachers to learn about mathematics anxiety. This is needed in order to help students of both sexes overcome their fears concerning mathematics. This should include elementary school mathematics teachers. The highest anxiety

and lowest confidence was found among those students who completed only one year of high school mathematics.

3. Elementary and secondary mathematics teachers need in-service training to learn ways to improve their students' feelings about the intrinsic value of mathematics and the challenge of word problems.

4. Since the observation was made that attitudes appeared more favorable toward mathematics among students who had more courses, teachers and counselors should seek ways to improve these attitudes with the hope that students will then choose to take more mathematics courses in high school than the minimum required.

V. SUGGESTIONS FOR FURTHER RESEARCH

The following suggestions are made for further research in this area:

1. More research should be done on students in a small town/rural setting. The 1977-78 NAEP report studies achievement for "advantaged urban, disadvantaged urban, and extreme rural" (1979, p. 45) but none for the type of community used in this study.

2. In doing further research, a standardized test should be used to measure achievement rather than GPA. This could show a different pattern from the one shown in this study.

3. Research needs to be done to find out if there is a relationship between the number of mathematics courses

students study or plan to study and their attitudes toward mathematics. Inferences have already been made (see Item 4, OTHER OBSERVATIONS), but they are not based on this research design.

4. Research should be conducted using the Anxiety scale developed by Fennema and Sherman and another one as well, such as the Mathematics Anxiety Rating Scale (Richardson and Suinn, 1972). It would also be useful to have another scale, for example, the Attitude Toward Mathematics Teacher Scale (Hume, 1979), to compare with this one to assess the attitude of the teacher toward the student as perceived by the student.

5. A research study might be designed to see if the sex of the teacher has any relationship to sex differences among students in attitude and achievement. Most of the mathematics teachers in the high schools of McMinn County are female. The question arises if the results would have been different in schools where male mathematics teachers were in the majority.

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APPENDICES

APPENDIX A

FENNEMA-SHERMAN ATTITUDE SCALES

Mathematics as a Male Domain

	Weight	
1.	+	Females are as good as males in geometry.
2.	+	Studying mathematics is just as appropriate for women as for men.
3.	+	I would trust a woman just as much as I would trust a man to figure out important calculations.
4.	+	Girls can do just as well as boys in mathematics.
5.	+	Males are not naturally better than females in mathematics.
6.	+	Women certainly are logical enough to do well in mathematics.
7.	-	It's hard to believe a female could be a genius in mathematics.
8.	-	When a woman has to solve a math problem, it is feminine to ask a man for help.
9.	-	I would have more faith in the answer for a math problem solved by a man than a woman.
10.	-	Girls who enjoy studying math are a bit peculiar.
11.	-	Mathematics is for men; arithmetic is for women.
12.	-	I would expect a woman mathematician to be a masculine type of person.

Mathematics Anxiety Scale

1.	+	Math doesn't scare me at all.
2.	+	It wouldn't bother me at all to take more math courses.

Weight

3. + I haven't usually worried about being able to solve math problems.

4. + I almost never have gotten shook up during a math test.

5. + I usually have been at ease during math tests.

6. + I usually have been at ease in math classes.

7. - Mathematics usually makes me feel uncomfortable and nervous.

8. - Mathematics makes me feel uncomfortable, restless, irritable, and impatient.

9. - I get a sinking feeling when I think of trying hard math problems.

10. - My mind goes blank and I am unable to think clearly when working mathematics.

11. - A math test would scare me.

12. - Mathematics makes me feel uneasy and confused.

Confidence in Learning Mathematics Scale

1. + Generally I have felt secure about attempting mathematics.

2. + I am sure I could do advanced work in mathematics.

3. + I am sure that I can learn mathematics.

4. + I think I could handle more difficult mathematics.

5. + I can get good grades in mathematics.

6. + I have a lot of self-confidence when it comes to math.

7. - I'm no good in math.

8. - I don't think I could do advanced mathematics.

9. - I'm not the type to do well in math.

Weight

10. - For some reason even though I study, math seems unusually hard for me.

11. - Most subjects I can handle O.K., but I have a knack for flubbing up math.

12. - Math has been my worst subject.

Usefulness of Mathematics Scale

1. + I'll need mathematics for my future work.

2. + I study mathematics because I know how useful it is.

3. + Knowing mathematics will help me earn a living.

4. + Mathematics is a worthwhile and necessary subject.

5. + I'll need a firm mastery of mathematics for my future work.

6. + I will use mathematics in many ways as an adult.

7. - Mathematics is of no relevance to my life.

8. - Mathematics will not be important to me in my life's work.

9. - I see mathematics as a subject I will rarely use in my daily life as an adult.

10. - Taking mathematics is a waste of time.

11. - In terms of my adult life it is not important for me to do well in mathematics in high school.

12. - I expect to have little use for mathematics when I get out of school.

Teacher Scale

1. + My teachers have encouraged me to study more mathematics.

Weight

2. + My teachers think I'm the kind of person who could do well in mathematics.

3. + Math teachers have made me feel I have the ability to go on in mathematics.

4. + My math teachers would encourage me to take all the math I can.

5. + My math teachers have been interested in my progress in mathematics.

6. + I would talk to my math teachers about a career which uses math.

7. - When it comes to anything serious I have felt ignored when talking to math teachers.

8. - I have found it hard to win the respect of math teachers.

9. - My teachers think advanced math is a waste of time for me.

10. - Getting a mathematics teacher to take me seriously has usually been a problem.

11. - My teachers would think I wasn't serious if I told them I was interested in a career in science and mathematics.

12. - I have had a hard time getting teachers to talk seriously with me about mathematics.

Effectance Motivation in Mathematics Scale

1. + I like math puzzles.

2. + Mathematics is enjoyable and stimulating to me.

3. + When a math problem arises that I can't immediately solve, I stick with it until I have the solution.

4. + Once I start trying to work on a math puzzle, I find it hard to stop.

	Weight	
5.	+	When a question is left unanwered in math class, I continue to think about it afterward.
6.	+	I am challenged by math problems I can't understand immediately.
7.	-	Figuring out mathematical problems does not appeal to me.
8.	-	The challenge of math problems does not appeal to me.
9.	-	Math puzzles are boring.
10.	-	I don't understand how some people can spend so much time on math and seem to enjoy it.
11.	-	I would rather have someone give me the solution to a difficult math problem than to have to work it out for myself.
12.	-	I do as little work in math as possible.

APPENDIX B

CONSENT FORM

I am conducting a study to determine if girls and boys have different attitudes toward mathematics. In addition, I plan to study how attitudes relate to achievement in mathematics. In a few days you will be asked to respond in agreement or disagreement with some statements concerning your feelings about mathematics. In order to compare these with achievement, I will obtain your mathematics grades from the school's records. This is the only information which I will use from your permanent record.

All information obtained from students and school records will be strictly confidential. No student's name will be used in the study. Only female and male groups will be compared.

Please complete the bottom of this form to indicate that you are willing to participate in this study. You may withdraw from participation at any time without penalty. If you are under 18, your parent's signature will be needed for your participation. Should you or your parent have any questions, please call me at 263-7905.

Thank you for your help in this project.

Peggy Hoyal, Teacher
Central High School
McMinn County

I have read the above explanation of the study on how students feel about mathematics and consent to take part in the study.

Name: ______________________

Date: ______________________

Parent's signature ______________________________
(If student is under 18)

APPENDIX C

FENNEMA-SHERMAN MATHEMATICS ATTITUDE SCALES AS ADMINISTERED TO STUDENTS

Directions

On the following pages is a series of statements. There are no correct answers for these statements. They have been set up in a way which permits you to indicate the extent to which you agree or disagree with the ideas expressed. Suppose the statement is:

Example 1. My math teachers have been interested in my progress in mathematics.

As you read the statement, you will know whether you agree or disagree. If you strongly agree, put a circle around (A) opposite Number 1 on your answer sheet. If you agree but with reservations, that is, you do not fully agree, circle (B). If you disagree with the idea, indicate the extent to which you disagree by circling (D) for disagree or (E) if you strongly disagree. If you neither agree nor disagree, that is, you are not certain, circle (C) for undecided. Also, if you cannot answer a question, put a circle around (C). Now mark your answer sheet. Do the same for example No. 2.

Example 2. Math puzzles are boring.

Do not spend much time with any statement, but <u>be sure to answer every statement</u>. Work fast but <u>carefully</u>.

There are no "right" or "wrong" answers. The only correct responses are those that are true <u>for you</u>. Whenever possible, let the things that have happened <u>to you</u> help you make a choice. Do not mark on the booklet.

THIS INVENTORY IS BEING USED FOR RESEARCH PURPOSES ONLY. ONLY THE RESEARCHER WILL KNOW WHAT YOUR RESPONSES ARE.

Mathematics Attitude Scales

1. My math teachers have been interested in my progress in mathematics.

2. Math puzzles are boring.

3. Mathematics makes me feel uncomfortable, restless, irritable, and impatient.

4. I am challenged by math problems I can't understand immediately.

5. I'll need a firm mastery of mathematics for my future work.

6. Mathematics usually makes me feel uncomfortable and nervous.

7. My teachers have encouraged me to study more mathematics.

8. Figuring out mathematical problems does not appeal to me.

9. I think I could handle more difficult mathematics.

10. I have a lot of self-confidence when it comes to math.

11. I don't think I could do advanced mathematics.

12. In terms of my adult life it is not important for me to do well in mathematics in high school.

13. It's hard to believe a female could be a genius in mathematics.

14. Mathematics will not be important to me in my life's work.

15. Females are as good as males in geometry.

16. Mathematics is of no relevance in my life.

17. I'm no good in math.

18. I like math puzzles.

19. I usually have been at ease during math tests.

20. I usually have been at ease in math classes.

21. I haven't usually worried about being able to solve math problems.

22. The challenge of math problems does not appeal to me.

23. Mathematics is for men; arithmetic is for women.

24. I would talk to my math teachers about a career which uses math.

25. I would expect a woman mathematician to be a masculine type of person.

26. My math teachers would encourage me to take all the math I can.

27. I am sure that I can learn mathematics.

28. I would rather have someone give me the solution to a difficult math problem than to have to work it out for myself.

29. I will use mathematics in many ways as an adult.

30. Math doesn't scare me at all.

31. Math teachers have made me feel I have the ability to go on in mathematics.

32. I expect to have little use for mathematics when I get out of school.

33. Taking mathematics is a waste of time.

34. I have found it hard to win the respect of math teachers.

35. Mathematics is enjoyable and stimulating to me.

36. Studying mathematics is just as appropriate for women as for men.

37. I don't understand how some people can spend so much time on math and seem to enjoy it.

38. I get a sinking feeling when I think of trying hard math problems.

39. Mathematics is a worthwhile and necessary subject.

40. My teachers would think I wasn't serious if I told them I was interested in a career in science and mathematics.

41. For some reason, even though I study, math seems unusually hard for me.

42. It wouldn't bother me at all to take more math courses.

43. Getting a mathematics teacher to take me seriously has usually been a problem.

44. I study mathematics because I know how useful it is.

45. Women certainly are logical enough to do well in mathematics.

46. I do as little work in math as possible.

47. My teachers think advanced math is a waste of time for me.

48. Knowing mathematics will help me earn a living.

49. When a question is left unanswered in math class, I continue to think about it afterward.

50. When it comes to anything serious, I have felt ignored when talking to math teachers.

51. I'll need mathematics for my future work.

52. Mathematics makes me feel uneasy and confused.

53. Math has been my worst subject.

54. Girls who enjoy studying math are a bit peculiar.

55. Most subjects I can handle O.K., but I have a knack for flubbing up math.

56. I would trust a woman just as much as I would trust a man to figure out important calculations.

57. I am sure I could do advanced work in mathematics.

58. I would have more faith in the answer for a math problem solved by a man than a woman.

59. When a math problem arises that I can't immediately solve, I stick with it until I have the solution.

60. I see mathematics as a subject I will rarely use in my daily life as an adult.

61. Once I start trying to work on a math puzzle, I find it hard to stop.

62. My teachers think I'm the kind of person who could do well in mathematics.

63. Generally, I have felt secure about attempting mathematics.

64. My mind goes blank and I am unable to think clearly when working mathematics.

65. Males are not naturally better than females in mathematics.

66. I have had a hard time getting teachers to talk seriously with me about mathematics.

67. Girls can do just as well as boys in mathematics.

68. When a woman has to solve a math problem, it is feminine to ask a man for help.

69. I'm not the type to do well in math.

70. A math test would scare me.

71. I almost never have gotten shook up during a math test.

72. I can get good grades in mathematics.

APPENDIX D

TABLE 5

VALUES OF F ON ANALYSIS OF VARIANCE TEST FOR DIFFERENCES IN MEANS OF FEMALES AND MALES ON GRADE POINT AVERAGE

	Gen. Math.	Alg. I	Geometry	Alg. II	Adv. Math.
F value	0.00	0.86	9.93**	6.93*	0.95

*Significant at .05 level.

**Significant at .01 level.

TABLE 6

VALUES FOR Z ON WILCOXON RANK SUM TEST FOR DIFFERENCES IN MEANS OF FEMALES AND MALES ON SIX ATTITUDE SCALES

Attitude	Gen. Math.	Alg. I	Geometry	Alg. II	Adv. Math.
Male Domain	-4.39**	-5.83**	-2.69**	-1.89	-4.11**
Anxiety	1.51	2.08*	0.42	0.43	0.15
Confidence	1.46	2.38*	-0.41	-0.42	0.09
Usefulness	0.36	-0.03	0.61	1.23	-1.55
Teacher	0.59	-0.86	-0.22	-1.28	-2.01*
Effectance	0.01	-0.41	0.75	0.38	-0.75

*Significant at .05 level. **Significant at .01 level.

VITA

Peggy Ann Fuson Hoyal was born on September 2, 1931, in Nashville, Tennessee. She received her elementary and secondary education in the Nashville Public schools, graduating from East Nashville High School in 1948. She attended Vanderbilt University, Carson-Newman College, and the University of Tennessee at Knoxville as she pursued a college degree. During the 1960-61 school year she taught mathematics at Etowah High School, Etowah, Tennessee. She graduated magna cum laude from Tennessee Wesleyan College in 1963, with a B. S. degree in Mathematics and Secondary Education. She taught seventh grade at City Park School, Athens, Tennessee, during the school year 1963-64, and the following year taught mathematics at Central High School in Knoxville, Tennessee.

In June, 1965, she moved to Topeka, Kansas, where her husband had been assigned as an Air Force chaplain. In 1965 and 1966, she was employed as a certification specialist by the Kansas Department of Public Instruction in Topeka. During the two school years from 1966-68, she taught mathematics at Auburn Junior High School in Auburn, Kansas. As a recipient of a summer study fellowship from the National Science Foundation, she did graduate study in mathematics at Kansas State Teachers' College at Emporia during the summers of 1966 and 1967.

Her family returned to Tennessee in June, 1968, and, from 1968 to 1970, she taught seventh and eighth grade mathematics at Englewood Elementary School in Englewood, Tennessee. Since August, 1970, she has been a mathematics teacher at Central High School of McMinn County, Englewood, Tennessee. She received the Master of Mathematics degree from the University of Tennessee, Knoxville, in 1971. She completed coursework for the Specialist in Education degree in 1981.

Peggy holds membership in the Tennessee Mathematics Teachers' Association and the National Council of Teachers of Mathematics. She organized a Mu Alpha Theta chapter at Central High School in 1973 and has served as its sponsor since that time. In 1981, she was sponsor of the Tennessee Association Chapter of Mu Alpha Theta.

She has been married, since 1951, to James A. Hoyal of Nashville, Tennessee. They have two children, J. Andrew, 27, and Anne, 25, both graduates of the University of Tennessee, Knoxville. Another daughter, Rebecca, 22, a senior at the University of Tennessee, was killed in an automobile accident in May, 1981. Rebecca was awarded a degree in English Education posthumously at the June, 1981, commencement.