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**GENDER DIFFERENCES IN MATHEMATICS ANXIETY
AND ACHIEVEMENT: GRADES 4-8**

by:
Juliet H. McGinley

A Thesis

Submitted in partial fulfillment of the requirements of the
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at
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Approved by

Professor

Date Approved 5/2/00

ABSTRACT

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Gender Differences in Mathematics Anxiety and Achievement: Grades 4-8

May, 2000

Advisors: Dr. Roberta DiHoff

Dr. John Klanderman

School Psychology Program

The purpose of this study was to investigate gender differences in mathematics anxiety as it is related to mathematics achievement. It was expected that there would not be a gender difference in mathematics achievement, but that there would be a gender difference in math anxiety. Specifically, it was expected that females would have a higher math anxiety than males, and that this difference would magnify in the higher grades. The participants were 250 students in grades 4-8 from a Catholic elementary school in a middle-class suburb in Southern New Jersey. Prior to their mathematics midterm examination, the participants completed the Mathematics Anxiety Scale for Children (MASC), a 22-question Likert-response survey. The anxiety scale was coded to match each participant's mathematics midterm score, which was provided by the student's teacher. The results were analyzed using a two-way Analysis of Variance (ANOVA). The results of the study were unexpected. First, there was no gender difference in math anxiety. Second, there was a gender difference in math achievement, that, as a group, the females performed significantly better than the males.

MINI-ABSTRACT

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The purpose of this study was to investigate gender differences in mathematics anxiety as it is related to mathematics achievement. The participants were 250 students in grades 4-8. Anxiety was measured using the Mathematics Anxiety Scale for Children (MASC) and achievement was measured by the mathematics midterm score. The results were analyzed using a two-way Analysis of Variance (ANOVA). The results indicated that there was no gender difference in math anxiety but that there was a gender difference in math achievement.

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Chapter One: **The Problem**

Need

There is an abundance of research and commentaries on gender differences and achievement in both professional and popular literature. However, the results of this research have not been consistent. While some find significant differences of achievement in specific domains, others assert that gender differences are nothing more than cultural stereotypes that have no statistical basis.

An educational domain that has received a great deal of gender-related attention from researchers is the field of mathematics. For example, there is much research that supports male dominance in test and task achievement in mathematics. Males have been shown to perform higher than girls on the mathematics section of the Scholastic Aptitude Test as well as the qualitative section of the Graduate Record Examination (Halpern, 1997). However, in a national longitudinal study of students who were tested in mathematics achievement in eighth grade and again in tenth and twelfth grades, there were no significant gender differences when measures of central tendency were examined (Fan, Chen & Matsumoto, 1997). With such a variety of results in the literature, it is difficult to disseminate whether there are gender differences in mathematics, and, if so, when are the differences prominent and what factors may contribute to these differences?

Although there is substantial research to support that there are no gender differences in overall mathematics achievement, it does not account for the gender imbalance of enrollment in higher level math courses and math-related careers. For example, MathCounts, a national mathematics competition for seventh and eighth graders,

has only 12-20% female participation on the national level (Eldridge, 1999). Achievement being equal, why are females not involved in higher-level math activities and careers?

There is research that suggests the gender difference lies in areas other than achievement, such as confidence, interests, attitudes and anxiety. There is a need to pursue these possibilities for the under representation of females in math-related career fields and develop and implement strategies to increase their involvement.

Purpose

The subjects of this study included male and female students in fourth through eighth grades. They were administered the Mathematics Anxiety Scale for Children (MASC) (Chiu & Henry, 1990) and their anxiety score was paired with their score on their mathematics midterm examination. A two-way Analysis of Variance (ANOVA) was computed. The purpose of the study is to identify gender differences and math anxiety as it relates to mathematics achievement. These results may be helpful to the school's administration and faculty to consider making adaptations to the curriculum or teaching style to meet the need of the students.

Hypothesis

There is no gender difference anticipated to be observed in overall math achievement. However, it is expected that there will be a gender difference in math anxiety. It is hypothesized that this difference will intensify in the higher grade levels.

Theory

The purpose of this study is to investigate gender differences and math anxiety as it relates to mathematics achievement. There is a range of theories which account for gender differences and achievement. A sampling of these theories will be presented. It is also important to acknowledge that anxiety, used in this context, as a state and not a universal trait.

There is substantial research that suggests that patterns of gender differences in achievement of specific domains are the result of biological factors and physical differences in brain structure. Kimura (1992) accounts for these differences by theorizing that hormonal differences, occurring in prenatal and postnatal development, ultimately affect the organizational function of the brain. She cited studies done that have correlated levels of androgens (which both males and females have, but females have lower levels) with performance on tests of mathematical reasoning and spatial manipulation.

Foss (1996) argued against the biological theory of gender differences, citing that the role of environment is minimized in the theory. He asserts that by age three, children are aware of, and have already learned, gender roles. Further, he stated that it is well-known that experience can have an affect on brain structure. Therefore, biology alone cannot be the only considered variable in brain structure differences between males and females; one must also consider environmental and experiential factors.

Another theory behind gender differences and achievement is that of different learning styles between males and females. Hammer and Dusek (1995), using Gardner's multiple intelligences theory, suggested that males may have higher cognitive-logical intelligence and females have a higher linguistic intelligence. Historically, the traditional educational system in this country has focused on the cognitive-logical type of intelligence. Therefore, the gender discrepancy in certain achievement scores, such as math and

science, may be due to the fact that information is being presented in a manner that is better received by the “male” style of learning as opposed to the “female” style of learning.

Finally the use of “anxiety” in this study is related to a state of anxiety and not an encompassing anxiety trait. According to the trait-state theory, a trait is considered to be an enduring behavioral disposition, whereas a state is referred to as a temporary predisposition, generally in response to a stimulus (Cohen & Swerdlik, 1999). Therefore, in the context of this study, a person with high math anxiety, for example, may be in an anxious state when presented with mathematics. However, it does not imply that the individual is a generally anxious person.

Definitions

Anxiety/Math anxiety: In the context of this study, anxiety is referring to a “state” of anxiety in the presence of mathematics stimuli, and not necessarily an enduring behavioral characteristic of the individual.

Mathematics Achievement: In the context of this study, mathematics achievement is being measured by scores on the students’ mathematics midterm examination.

Mathematics Anxiety Scale for Children (MASC): Twenty-two question scale with responses on a four-point Likert-style scale. Developed by Chiu and Henry (1990) by adapting the Mathematics Anxiety Rating Scale for use by children.

Assumptions

It is being assumed that although all of the subjects in this study attend the same Catholic school, the results could be generalized to other populations. It also must be assumed that, although the subjects are from a private school, there will not be any other

motivational factors that may not be present in the student population of public schools to interfere with the generalizability of the study.

Another assumption being made is in regard to the scale being used to quantify math anxiety. The items on the Mathematics Anxiety Scale for Children (MASC) have high face validity. Therefore, it must be assumed that the subjects will respond accurately to represent their subjective feelings and not respond in a manner in which they perceive is the expected response.

Limitations

The most obvious limitation of this study is the sample. For logistic reasons, the subjects are from an incidental sample. The subjects are students attending a Catholic elementary school in a middle-class suburb. It is likely that these students are less heterogeneous (financially, racially and religiously) than students in public schools. Also, it is possible that these students have a different attitude or motivation towards school than students in public school, because they have chosen this school and their family may be making financial sacrifices in order for them to attend.

Another limitation is the means for measuring mathematics achievement. Midterm examination scores are being used, and each grade level has taken an examination that was developed and scored differently. There is no standardization across grade levels with this measure.

Overview

The specific design of the study is presented in Chapter Three. In Chapter Four, the results of the study are analyzed and interpreted. In the final chapter, Chapter Five, there is a discussion of the results and implications for future research.

In the next chapter, Chapter Two, reviews of relevant literature to this study are presented.

Chapter Two: **Review of the Literature**

Math achievement and anxiety, and the differences between males and females, have commanded a great deal of attention in professional literature and popular media. The presumption of a “math gene” (Benbow and Stanley, 1980) that is dominant in males has been debated for the past twenty years. There has been much debate and little concurrence of ideas in this highly debated field.

In Chapter Two, there will first be an overview of some of the gender-related debates surrounding math achievement. Next, there will be a section illustrating some of the research done on math attitudes and anxiety, and the gender implications that they have. Third, there will be a review of some of the techniques proposed to reduce math anxiety in students. The final section will closely review literature which is directly related to this study.

Overview of Issues Surrounding Sex Differences in Math Achievement

The issue of gender differences in mathematics achievement is an area of popular debate in the literature. There are those who acknowledge that there are gender differences. For example, why is it that there are substantially more males who enter mathematically-based career fields? Jensen and McMullen (1995) investigated gender differences of the interests of entering a math or science related career of gifted fifth and sixth grade students. Although there were no gender differences in fifth grade, there was a

significant relationship present in the sixth grade. Another example is that of a national math competition for seventh and eighth graders, MathCounts. It is reported that approximately 40% of the participants at the chapter level are females. That percentage drops to 30% at the state level and 12%-20% at the national level (Eldridge, 1999). There are also those who deny gender differences, arguing that it is just a myth and a perpetuation of stereotypes. There are also those, regardless of whether or not there are gender differences, who argue against even having the debate. Then, of those who agree that there are gender differences, there are some who attribute those differences to innate characteristics, and those who support environmental influences as the cause for such differences. There are also researchers who draw a relationship between gender differences of achievement with other factors, such as attitudes, confidence and anxiety.

There are those reports that there exist gender differences in scholastic achievement, particularly that of mathematics due to innate biologically-based brain differences between males and females (Kimura, 1992). There are also reports that support a biological basis for gender differences in mathematics when other environmental factors are controlled (Benbow and Stanley, 1980). However, for every report supporting these theories, there are critics to argue them. In response to the argument proposed by Kimura (1992) that observed differences in abilities are innate, due to hormonal influences, Foss (1996) expressed reservations. While Kimura asserted that hormones create male and female brains to be “wired” differently. She also reported a relationship between testosterone levels and test performance between males and females. Foss cautioned that this is a correlational study, which cannot conclude causation. Further, Foss argued that in the studies performed by Kimura to support an innate basis for gender differences, there were no subjects younger than three years old. Therefore, according to Foss, pure innateness cannot conclusively be the reasons for certain behaviors. By age three, most children have experienced environmental influences and have learned sex roles.

In addition to the nature versus nurture debate for the causes of gender differences in math achievement, there is a substantial amount of literature which questions the very existence of gender differences, and, if they do exist, offers the possibility of a relationship between those differences and learned factors, such as attitudes and anxiety.

Many researchers have conducted studies and written commentaries to debunk the stereotype that males have superior achievement in mathematics. Campbell and Storo (1996) assert that one's gender may provide biological information, it is not an effective predictor of abilities or interests. Caporrino (1990) found no gender differences in eighth grade students in mathematics achievement scores, problem-solving strategies or self-report scores. There was, however, a gender difference in the relationship between confidence and the problem-solving strategies measure. While boys showed a direct relationship between these two measures, girls exhibited an inverse relationship.

Regardless of the results of the debate, Hammer and Valentine (1995) are skeptical of emphasizing "brain difference research" because it will only perpetuate the stereotypes. Historically, males have been thought to have superior spatial skills and females have elevated linguistic abilities. Boys have been thought to be more "right-brained" and girls more "left-brained". These stereotypes, whether true or not, tend to lead to social expectations. While there are benefits to reporting the strengths and talents of a group, one must also be cautious about making it a self-fulfilling prophecy. Such expectations could decrease self-confidence and increase anxiety, regardless of achievement level.

Review of Literature on Math Anxiety

An individual's attitudes towards any subject is an important factor in assessing the individual's interest level and motivation towards the subject. Attitudes towards math is a topic that has been receiving attention in the literature. Common sense dictates that if a student has a negative attitude towards a subject, more advanced pursuit of the subject is

unlikely, regardless of achievement level. Specific factors within the study of attitudes which are important to consider are confidence, self-efficacy beliefs and anxiety.

Math anxiety, in particular, has received a great deal of attention. Anxiety, in general, occurs automatically in response to a threatening stimuli. When feelings of anxiety persist, the natural response is to remove oneself from the source of the anxiety. When considering anxiety, therefore, in the context of mathematics, it is important to realize that a student who may be experiencing anxiety in response to math, will be likely to avoid math in the future. Students who have experienced math anxiety are less likely to choose to enter a math-related career.

Thorndike-Christ (1991) investigated the attitudes of middle-school students towards mathematics using the Fennema-Sherman Math Attitude scales. The results indicated that a student's attitudes towards math was a reliable predictor of final course grade and likelihood of taking more advanced math courses in the future. While the reports of this study indicated that females had more positive attitudes towards math than expected, the females had less confidence in their ability to learn math, less interest in pursuing math-related careers, and higher math anxiety than did boys. The author suggests that, given the results, "important gender differences still exist" (Thorndike-Christ, 1991).

In a study of self-efficacy beliefs in mathematical problem-solving in high school students, Pajares and Kranzler (1995) found no significant gender differences in performance or self-efficacy. However, there was a difference in math anxiety. This suggests that math achievement and performance is not necessarily predictive of feelings of math anxiety. Therefore, it is possible that among students of equal achievement, some may have math anxiety which may be a deterrent to them entering math-related fields.

Math anxiety has also been studied among college students, as it is in college when many individuals begin making career-related decisions. Zettle and Houghton (1998) studied the relationship of math anxiety with that of social desirability in college students.

While it was expected that females would report a significantly higher math anxiety than the males, that is not what happened. Females did report higher math anxiety, but not at significant levels. Possible explanations for the results of this study is that the math anxiety rating scale was administered with rating measures of social desirability. Lower math anxiety may have been reported in conjunction with responding in a “socially desirable” manner.

In an experiment conducted by Zanakis and Valenzi (1997), previous studies were cited which both support and reject a correlation between math anxiety and math performance. In their study, however, they assessed math anxiety, among other factors, to undergraduates in a business statistics course at the beginning of the semester. The results indicated that the math anxiety scores were predictive of final course grade. While causation cannot be inferred, it is possible that student’s achievement could have an effect on their overall anxiety level, or that anxiety level may act as a self-fulfilling prophecy in terms of observed achievement.

Reduction of Math Anxiety

Amidst all of the literature about math anxiety are those which propose methods to decrease math anxiety. Proposed reduction measures include techniques to reduce anxiety in the student as well as in teachers. Many teachers, particularly elementary school teachers, experience math anxiety themselves. Therefore, math anxious teachers may be impacting their students’ anxiety.

The Los Angeles School District has implemented a program, Friendly and Teachable Hands-On Math (FATHOM) in an effort to reduce math anxiety in elementary teachers (Eckmier and Bunyan, 1995). Through presenting essential nonarithmetic mathematical problems, the FATHOM program has been successful in reducing math anxiety and increasing math expertise in elementary school teachers.

Harper and Daane (1998) surveyed pre-service elementary school teachers enrolled in an elementary mathematics methods course. Many of these teachers possessed math anxiety, which they reported had been present since elementary school. Many similarities in their experiences included rigid instructional practices, time-pressures, embarrassment in front of the class, and pressures to do math the “right” way. However, by pre-service teachers being aware of factors that may contribute to math anxiety, they can make a conscious effort to reduce or eliminate those factors. For example, if teachers present materials more creatively and in a real-life context, it may become more applicable and less frustrating to students. Other suggested strategies are game-playing, problem solving and small-group activities.

Steele and Arth (1998) agreed with strategies that focus on problem-solving. They suggested that when a student makes an error, a unique opportunity is presented for the teacher to learn how the child arrived at the answer. By avoiding statements like “This is a better way of doing it” and instead present a different way of doing it may reduce negative math experiences. Steele and Arth further advocated for the use of manipulatives in the instruction of math. Also, they supported the use of math journal writing. Having students verbally express their concerns and anxieties about math, and having their teacher show interest in their concerns, can lead to a more positive experience and a reduction in anxiety.

Biller (1996) promoted a relaxed learning environment and creative teaching strategies as methods for reducing math anxiety in students. By broadening the math curricula to account for a variety of learning styles, more students will have higher confidence and lower anxiety towards math.

A gender-related method to reduce anxiety for female students involves teaching math in single-sex classes. In a study done by Campbell and Evans (1997), female high school students’ anxiety was assessed at the beginning of the school year. The females were then randomly assigned to either a single-sex or co-ed math class. When their

anxiety was assessed at the end of the school year, students in the single-sex math class reported less anxiety and students in the co-ed class reported an increase in anxiety at the end of the school year. The authors of this study asserted that “females flourish in single-sex environments” (Campbell and Evans, 1997). While their results were significant, it should be noted that the sample size was 15 female students, and the study was conducted in a small Catholic college preparatory high school.

Fiore (1999) emphasized a more individualized approach to combating math anxiety. He suggested engaging students in writing a “Math and Me” essay which accounts for the student’s history of math experiences. Through this writing assignment, teachers can become aware of when a student may have had a negative math experience. By identifying these incidents, teachers can encourage students, make accommodations and introduce strategies to develop positive and realistic self-concepts.

Review of literature closely related to this study

The purpose of this study is to investigate gender differences in the relationship of math anxiety and math achievement in elementary and middle school students, particularly students in grades four through eight. Therefore, the review of the following research articles have had impact on the course of my study.

A study that has been frequently referenced in much of the literature of math achievement and popular media is that study done by Benbow and Stanley (1980). Benbow and Stanley (1980) measured sex differences in mathematics ability of seventh and eighth graders with presumably similar math experiences. The study examined 10,000 students over eight years through talent searches. Students were only selected if they scored within the top 5% of a standardized math test.

The students took both parts (mathematics and verbal) of the Scholastic Aptitude Test (SAT). The results indicated that on the verbal section, boys and girls performed

similarly. However, on the math section, boys performed consistently better. For instance, in the 1976 sample, 58.3% of eighth grade boys scored above 600 while 0% of the girls did. Although the seventh and eighth grade girls performed at an inferior level to that of the boys, the girls did relatively better than college-bound girls than the boys did. Also, the seventh graders average score was at the 30th percentile of college-bound seniors and the eighth graders were at the 50th percentile. This indicates that the subjects in this sample were, overall, high-achievers.

This study has received a great deal of attention in professional literature and in popular media. It has also received a great deal of criticism. First, the sample was a high achieving group of students, which may not be a representative sample of the population. Second, the SAT is a test designed to predict first year college grades, not necessarily overall achievement.

Another important study was that done using the data from the National Education Longitudinal Study of 1988 (NELS:88) (Fan, Chen, Matsumoto, 1997). The findings of this study contradict the stereotypical expectation of male dominance in mathematics. Unlike many of the other studies done to assess math achievement that have used convenience samples, this study used a nationally representative sample. The subjects were part of the longitudinal database of the NELS:88, in which approximately 24,000 students who were in the eighth grade in 1988 were followed. Four waves of data are available: 1988 (eighth grade), 1990 (tenth grade), 1992 (twelfth grade) and 1994 (two years after high school graduation). This study only used data from the first three waves. The results of the investigation indicate that gender differences among all three grade levels were quite minimal. However, when the scores in the upper end of the distribution were examined (at or above the 75th, 90th and 95th percentile), significant differences were observed. Male students outnumbered female students in the extreme distribution range. Also, the percentage of female students at the higher end of the distribution

decreased at each increasing grade level. In addition, as the score range became more extreme, the gender differences intensified. The authors of this study also looked at gender differences across four ethnic group samples (Asian, Hispanic, African American and White). The pattern of gender differences for three of the four ethnic groups (Asian, Hispanic and White) were similar to that of the entire sample. However, the African American sample presented an opposite pattern; more females scored at the extreme high end than males.

The researchers of this study further classified math achievement into the following five levels:

Level 1: Simple arithmetic operations on whole numbers

Level 2: Simple arithmetic operations with decimals, fractions, powers and roots

Level 3: Simple problem solving, requiring understanding of low-level math concepts

Level 4: Understanding intermediate-level math concepts and having the ability to formulate multi-step outcomes to word problems

Level 5: Proficiency in solving complex multi-step word problems and the ability to demonstrate knowledge of math material found in advanced math courses

The highest level of achievement attained at the eighth grade was Level 3, tenth grade was Level 4 and twelfth grade was Level 5. The gender differences at the levels of achievement was consistent with that of the total sample. In Grade eight at Level 3, there was very little gender difference (51.55% male, 48.45% female). In tenth grade, at Level 4, there was still a small difference, but more than in eighth grade (55.12% male, 44.88% female). However, at Level 5 in twelfth grade, there was the greatest difference, with 64.97% male and 35.03% female.

The authors of this study suggested that although there was no gender differences in math achievement when the entire sample was studied, the differences at the high ends of the distribution has meaning. Assuming that only those students who have high math achievement enter into mathematically-demanding careers (such as engineering and various technology fields), it would make sense that more male students are entering these fields. Therefore, perhaps it is important to focus on the higher achieving students to investigate the differences in that small sample as opposed to the entire population.

In addition to reviewing literature on gender differences and math achievement, gender differences and math attitudes and anxiety is also important. Melancon (1993) studied 623 students in sixth through twelfth grade in urban public schools to assess gender differences by addressing several questions about students' attitudes towards math. Attitudes were assessed through the use of the Fennema-Sherman Mathematics Attitudes scale. The results of this study were reported as "surprising" by the author. The researchers found that females had more positive attitudes towards math than males, except on the dimension of anxiety. Therefore, despite females' inflated motivation and perceived encouragement for math, they still felt more anxious about math than did males. In terms of differences in attitudes across grade levels, students felt higher anxiety at upper grade levels, which may be related to increasingly difficult and more complex course work. The author did not propose any possible relationship to these "surprising" results.

Gutbezahl (1995) suggested that negative expectancies toward females in the study of mathematics play a role in females' attitudes, confidence and performance in math. She stated that "there is a common belief that females are less math capable than males". Classroom studies have shown that this is an effect as early as the third grade. While some research has shown differences in math achievement, there are others who support that there are no significant differences in elementary school boys and girls and little difference

in males and females in older grade levels. Gutbezahl proposes that it is parents and teachers expectancies that influence students' attitudes towards math, and these expectancies may be related to the gender differences.

Parents have been shown to have different expectations for their sons than their daughters. Many parents who have sons and daughters who are performing at similar levels in math attribute their son's ability to innate factors and their daughter's ability to effort in compensating for lack of ability. It has also been found that people with success attributed to effort have less self-esteem than if it was attributed to innate characteristics. Further, the author cited several examples of differential expectations by teachers which resulted in lower confidence.

The author further cited that girls tend to expect less of themselves and have lower confidence in math abilities, despite successes in school, than males. By the time females enter college, confidence and actual math ability is practically uncorrelated. Low self-esteem is not a general characteristic of girls, but it is more significant in relation to math ability than it is in boys.

Finally, girls have been shown to have higher math anxiety than boys. One function of anxiety is to alert the individual of potential danger. Anxiety also causes the individual to process information differently. Therefore, anxious students may have selective attention that may lead to focus on irrelevant parts of a math problem which may account for deflated performance levels.

The final study presented incorporates the issues of gender differences of math achievement with math anxiety. Satake and Amato (1995) investigated fifth and sixth grade Japanese students in Tokyo, Japan.

The researchers used the Mathematics Anxiety Rating Scale-Elementary (MARS-E), a frequently used measure for math anxiety in the United States. They translated it from English to Japanese and back to English to account for anything lost in

the translation. The examiners also looked at the course grades of the students from the previous semester as a measure of achievement. The results of the study were somewhat consistent with that of American students. There was an inverse relationship between math anxiety and achievement. Also, females reported a significantly higher level of anxiety than males, regardless of grade level. Further, the researchers in this study identified several factor loadings in the MARS-E. Among them was a factor of performance anxiety. It was found that high achieving Japanese students had greater classroom performance anxiety than did lower achievers. This is an area that requires further study in American children.

Summary

Because the issues presented are so hotly debated, it is a difficult task to summarize the findings. What is not very much disputed is that males have a higher rate of entering into math-related career fields. The research that has indicated significant gender differences in higher achieving students (Fan, Chen, and Matsumoto, 1997; Benbow and Stanley, 1980) may account for these discrepancies. The longitudinal study of 1988 probably is the most conclusive in providing a representative sample that does not have overall gender differences. While other studies may show gender differences in math achievement, they may be from non-representative samples.

The other major issue addressed in this chapter is the gender differences of math attitude and anxiety. The majority of the literature does suggest that, regardless of achievement level, females tend to have higher math anxiety and lower math confidence than boys. In an educational environment, the final section of this chapter addressed possible interventions to reduce anxiety.

Chapter Three:
Design of the Study

Participants

The sample of this study were 250 students (approximately half male and half female) who were in fourth through eighth grade in a suburban Catholic elementary school in South Jersey. The school is located in a middle-class suburb. The majority of students are Caucasian and Roman Catholic. The students represented all achievement levels.

Table 3.1 illustrates the specific breakdown of males and females from each grade level.

Table 3.1

GENDER DISTRIBUTION OF PARTICIPANTS

	MALES	FEMALES
FOURTH GRADE	25	25
FIFTH GRADE	31	22
SIXTH GRADE	18	34
SEVENTH GRADE	25	26
EIGHTH GRADE	23	21
TOTAL	122	128

Measures

The following instruments were used in this study:

The Mathematics Anxiety Scale for Children (MASC). The MASC was developed by Chiu and Henry (1990) by adapting the Mathematics Anxiety Rating Scale (MARS) for use by elementary and middle school students in grades four through eight. The MARS is a popularly used instrument to measure math anxiety in adolescents and adults. The development of the MASC from the MARS involved revisions of items on the MARS to make the scale applicable for use by young children. The MASC includes twenty-two items as opposed to twenty-four items on the MARS. Two items referring to statistics were excluded in the MASC, due to its inapplicability. Participants rated each item using a four point scale which corresponded with how much anxiety they felt.

The MASC has been tested as a reliable and valid instrument. There was high internal reliability evidenced through alpha coefficients. Construct validity was obtained by finding a significant negative correlation between the instrument and semester grades. There was also a positive correlation with a test anxiety measure and a negative correlation with a school achievement motivation scale rated for each student by his or her teacher.

Mathematics midterm examination scores. The students' scores from their mathematics midterm exam was matched with their anxiety score. The midterm was given to students in the beginning of January. A week of review was given by the teachers prior to administration of the exam.

Design

The participants in the study were administered the Math Anxiety Scale for Children (MASC) during their week of review prior to the mathematics midterm

examination by their classroom teacher. Each anxiety score was paired with the participant's midterm score. A two way analysis of variance was used to analyze the data, with grade level and gender as the independent variables and math anxiety and math achievement (via math midterm scores) were the dependent variables.

Testable Hypothesis

Null hypothesis #1: There will be no gender differences in math anxiety.

Alternate hypothesis #1: There will be a gender difference in math anxiety.

Null hypothesis #2: There will be no grade level differences in math anxiety.

Alternate hypothesis #2: There will be grade level differences in math anxiety.

Null hypothesis #3: There will not be an interaction between gender and grade level on math anxiety.

Alternate hypothesis #3: There will be an interaction of gender and grade level on math anxiety.

Null hypothesis #4: There will be no gender differences in math achievement.

Alternate hypothesis #4: There will be gender differences in math achievement.

Null hypothesis #5: There will be no grade level differences in math achievement.

Alternate hypothesis #5: There will be grade level differences in math achievement.

Null hypothesis #6: There will not be an interaction between gender and grade level on math achievement.

Alternate hypothesis #6: There will be an interaction between gender and grade level on math achievement.

Analysis

A two-way analysis of variance (ANOVA) was used to analyze the data. Although gender differences are the primary focus of this experiment, it was of interest to also consider grade level in the analysis, to examine whether gender differences are more intense at certain grade levels.

Summary

The purpose of this study is to examine whether there is a relationship between grade level and gender with math anxiety and math achievement. The participants in the study represent males and females in grades four through eight. The participants are all students from a Catholic elementary school in a small suburban town in Southern New Jersey. Math anxiety was measured by using a self-reported anxiety scale, the Mathematics Anxiety Scale for Children (MASC). Mathematics achievement was measured using the participant's grade on their mathematics midterm examination. The data was analyzed using a two-way ANOVA, where grade level and gender were the independent variables and math anxiety and math achievement were the dependent variables.

Chapter Four: **Analysis of Results**

Anxiety

Null hypothesis #1:

There will be no gender differences in math anxiety across grade levels.

The analysis of data for the scores on the Math Anxiety Scale for Children (MASC) yielded results which failed to reject the null hypothesis, with a significance value of .780.

Null hypothesis #2:

There will be no grade level differences in math anxiety.

The analysis of data yielded results which also failed to reject the null hypothesis, with a significance value of .510.

Null hypothesis #3:

There will be no interaction between gender and grade level on math anxiety.

Again, the results of the analysis of data produced significance levels of .343, which failed to reject the null hypothesis. (See Tables 4.1, 4.2, 4.3, and 4.4)

Table 4.1

MATH ANXIETY

	SIGNIFICANCE	REJECT OR FAIL TO REJECT NULL HYPOTHESIS
GENDER DIFFERENCES	0.78	fail to reject
GRADE DIFFERENCES	0.51	fail to reject
INTERACTION	0.343	fail to reject

Table 4.2

GENDER DIFFERENCES AND MATH ANXIETY

	MALE	FEMALE	TOTAL
PARTICIPANTS	122	128	250
MEAN	36.508	36.313	36.408
STD. DEV.	10.349	8.951	9.639

(SEE FIGURE 4.1)

Table 4.3

GRADE LEVEL DIFFERENCES AND MATH ANXIETY

	4th gr.	5th gr.	6th gr.	7th gr.	8th gr.	TOTAL
PARTICIPAN	50	53	52	51	44	250
MEAN	37.501	36.038	36.904	34.628	37.091	36.408
STD. DEV.	8.756	8.959	9.598	10.846	10.074	9.639

(SEE FIGURE 4.2)

Table 4.4

GENDER DIFFERENCES WITHIN GRADE LEVELS AND MATH ANXIETY

	4th male	4th female	5th male	5th female	6th male	6th female	7th male	7th female	8th male	8th female	total male	total female
partic.	25	25	31	22	18	34	25	26	23	21	122	128
mean	38.321	36.681	35.226	37.182	39.833	35.353	33.161	36.039	37.304	36.857	36.508	36.313
std.	8.769	8.845	8.445	9.723	11.511	8.183	10.827	10.887	12.212	7.351	10.349	8.951

(SEE FIGURES 4.3 AND 4.4)

Figure 4.1

Math Anxiety Scale for Children Gender Differences

Grades 4-8

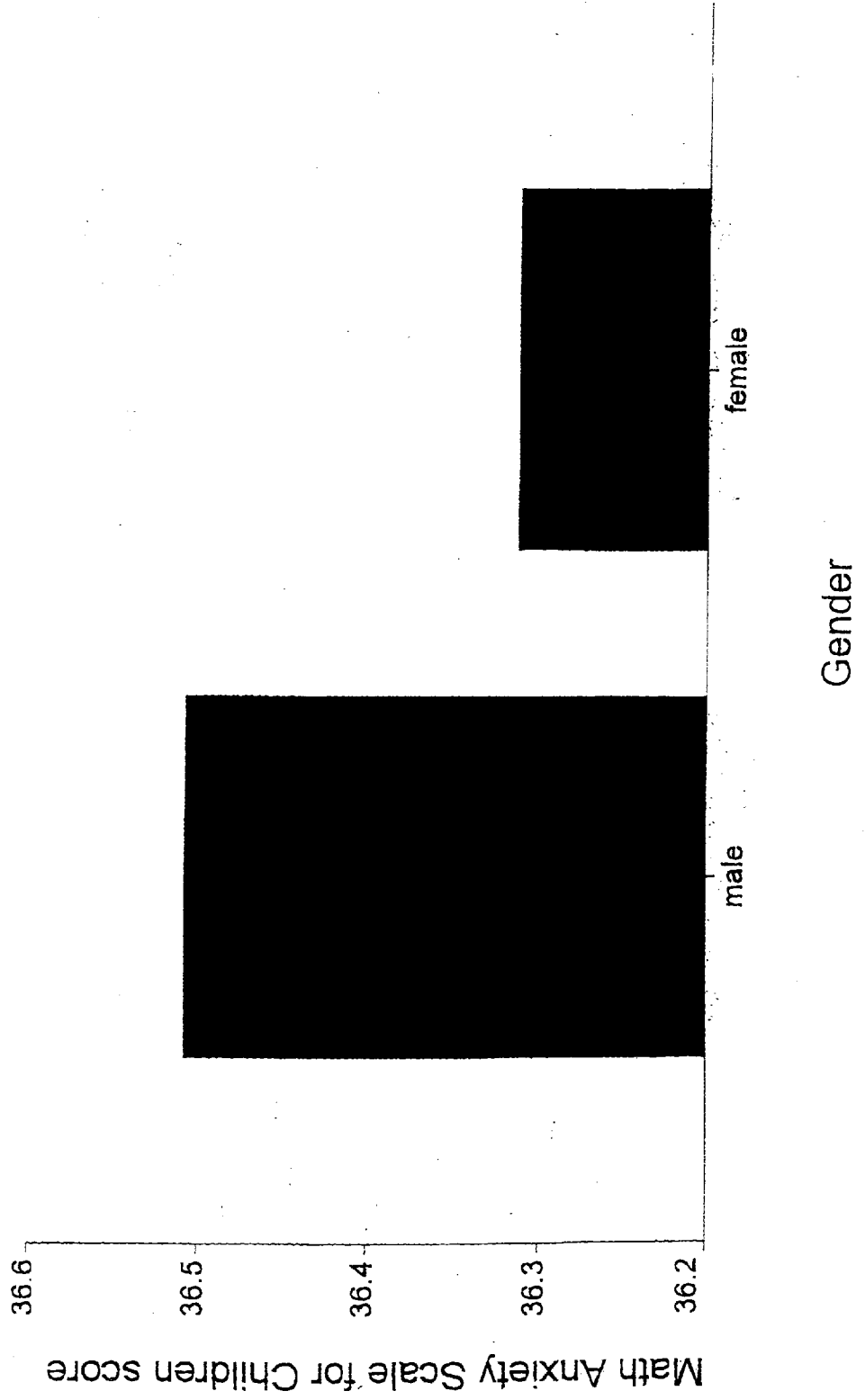


Figure 4.2

Math Anxiety Scale for Children Grade Differences

Grades 4-8

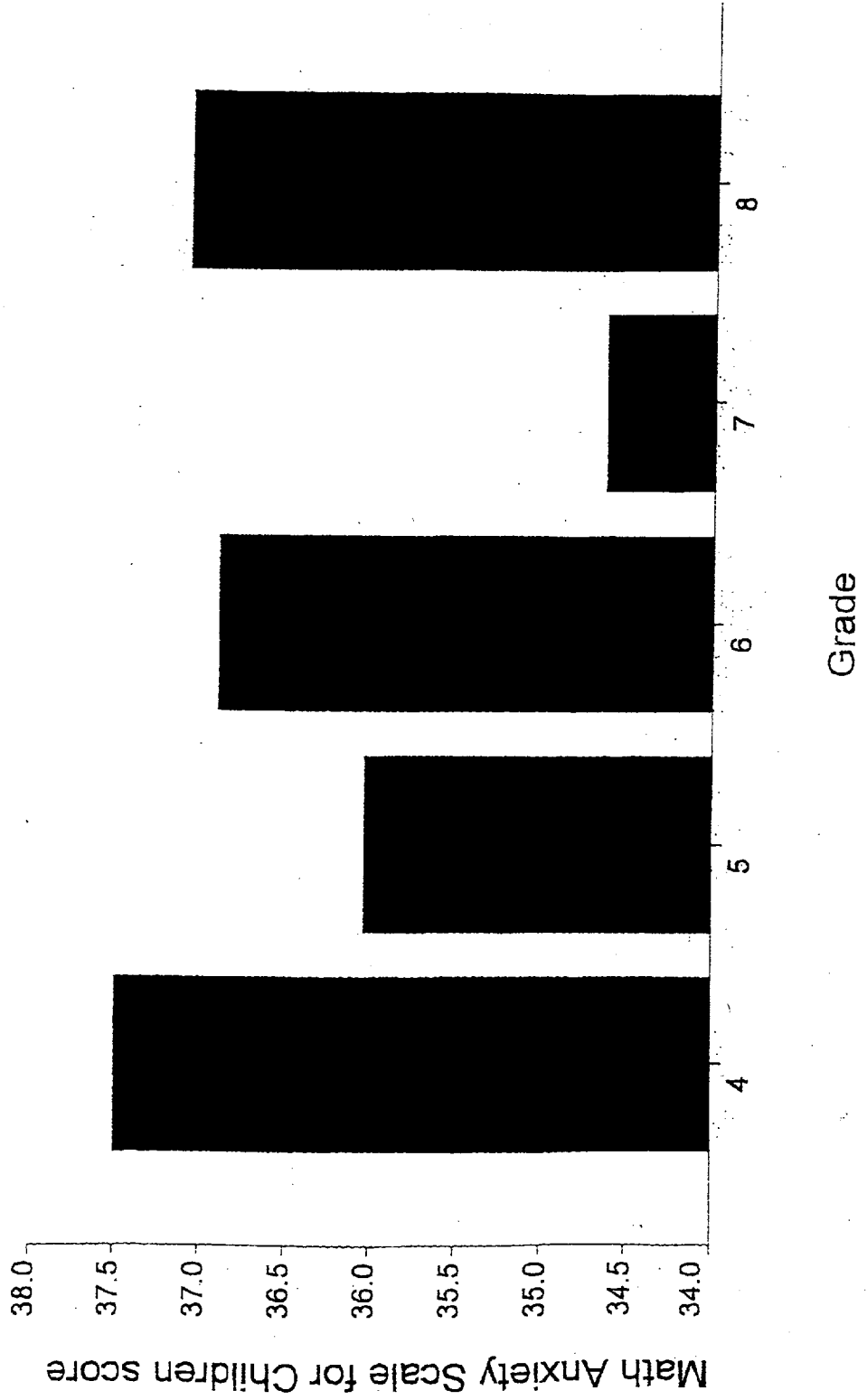
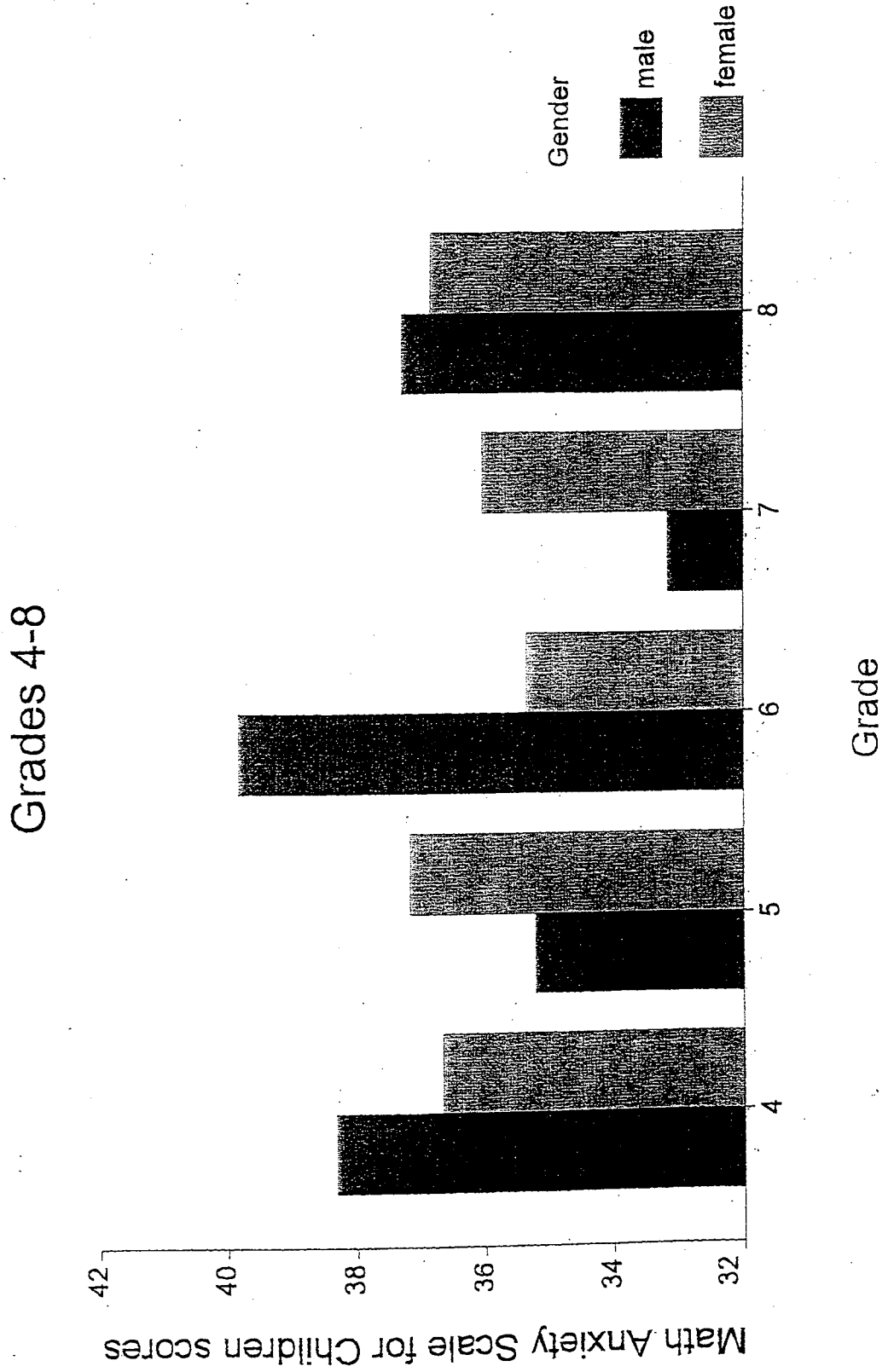


Figure 4.3

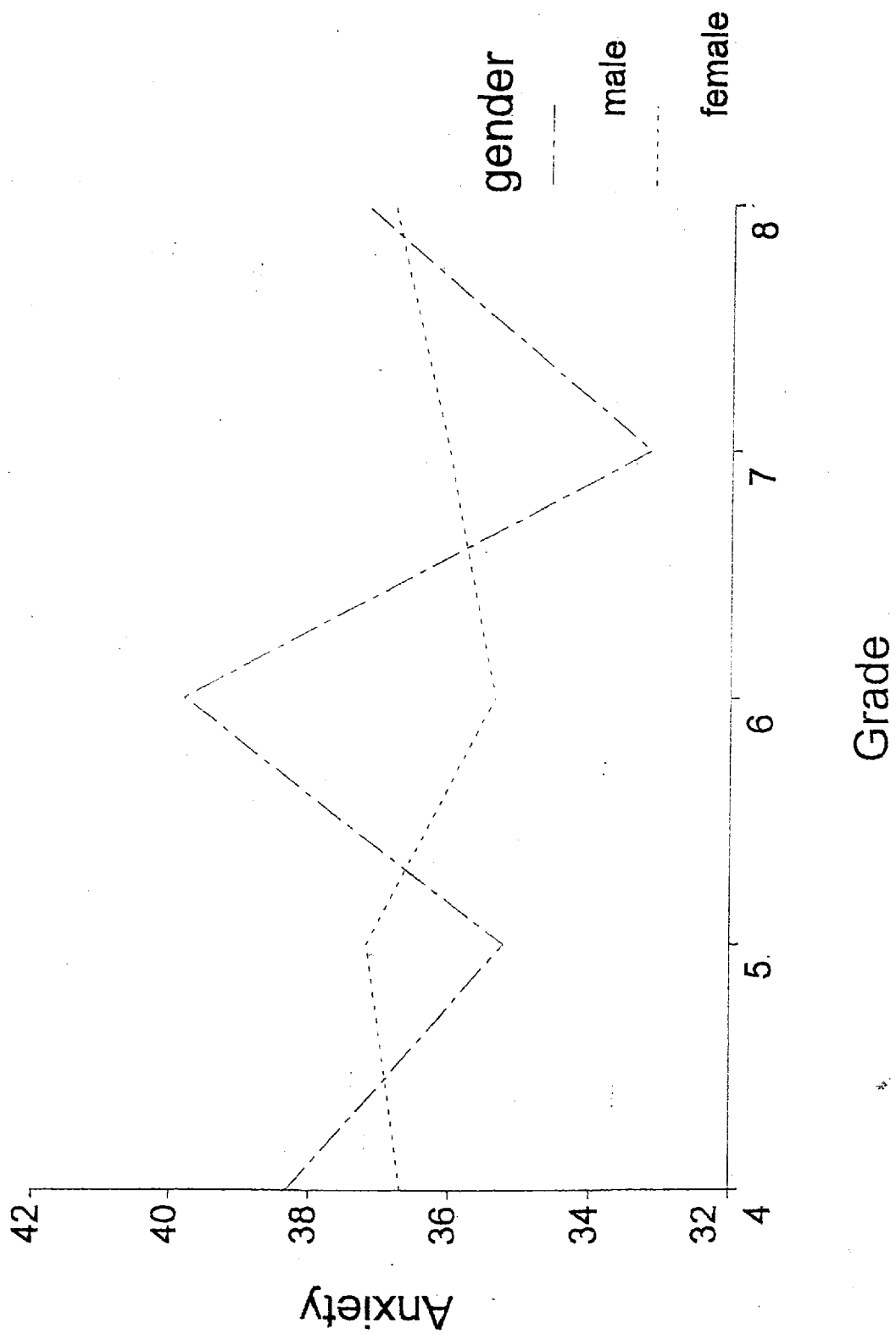
Gender and Grade Differences Math Anxiety Scale for Children scores



Anxiety and Gender Differences

Grades 4-8

Figure 4.4



Achievement

Null hypothesis #4:

There will be no gender differences in math achievement.

The analysis of data yielded a significance level of .043, which reaches significance, and therefore the null hypothesis is rejected.

Null hypothesis #5:

There will be no grade level differences in math achievement.

The results of the data analysis yielded a level of .031, which reaches significance. Therefore, the null hypothesis is rejected.

Null hypothesis #6:

There will not be an interaction between gender and grade level on math achievement.

The results of the analysis of data yielded a significance level of .790, which did not reach significance. Therefore, there was a failure to reject the null hypothesis.

Table 4.5

MATH ACHIEVEMENT		
	SIGNIFICANCE	REJECT OR FAIL TO REJECT NULL HYPOTHESIS
GENDER DIFFERENCES	0.043	reject
GRADE DIFFERENCES	0.031	reject
INTERACTION	0.79	fail to reject

Table 4.6

GENDER DIFFERENCES AND MATH ACHIEVEMENT			
	MALE	FEMALE	TOTAL
PARTICIPANTS	122	128	250
MEAN	81.5	85.203	83.396
STD. DEV.	13.106	12.569	12.941

(SEE FIGURE 4.5)

Figure 4.5

Midterm Scores Gender Differences

Grades 4-8

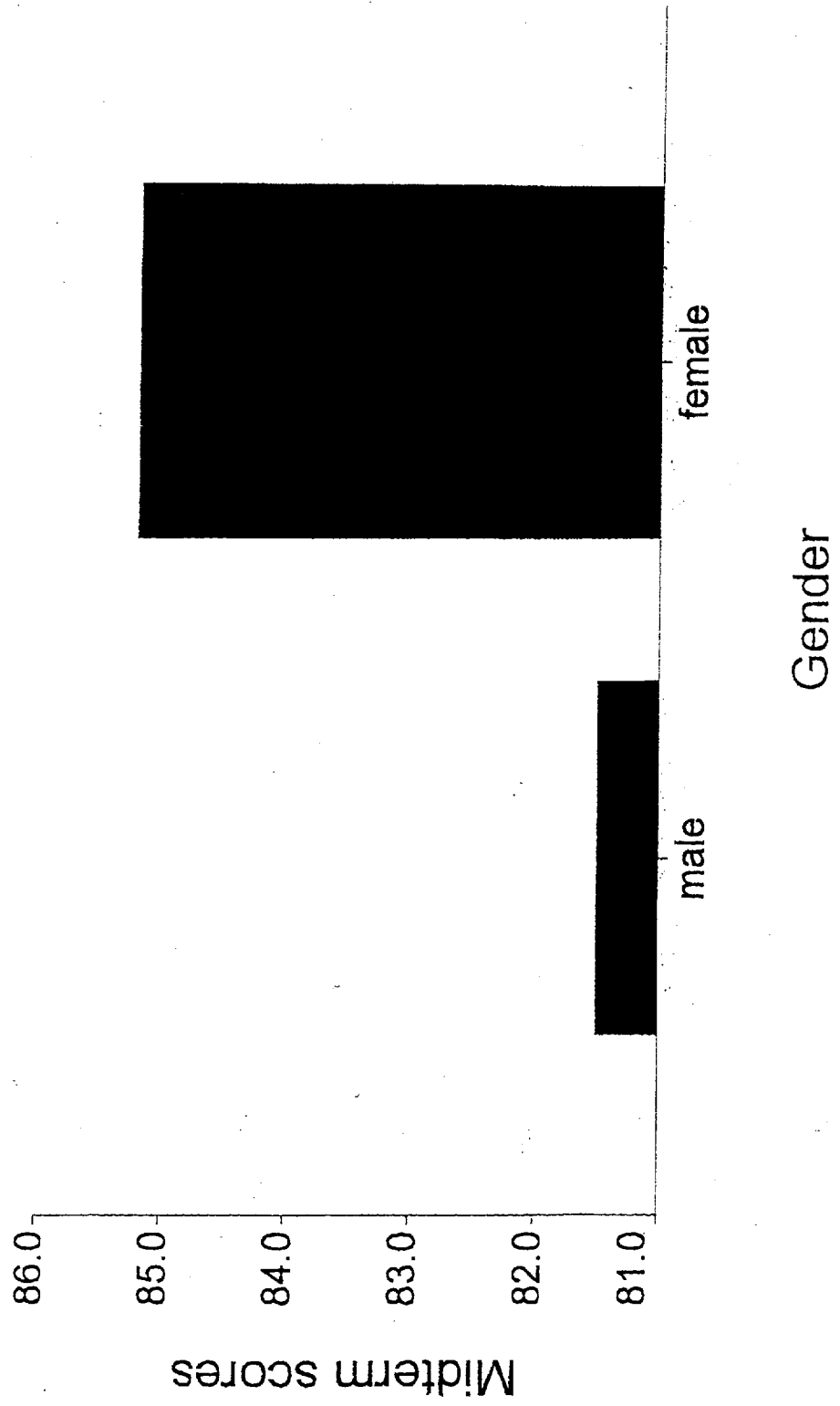


Table 4.7

GRADE LEVEL DIFFERENCES AND MATH ACHIEVEMENT

	4th gr.	5th gr.	6th gr.	7th gr.	8th gr.	TOTAL
PARTICIPANT	50	53	52	51	44	250
MEAN	81.821	84.169	88.212	79.765	82.773	83.396
STD. DEV.	14.418	12.406	10.948	13.237	12.379	12.942

(SEE FIGURE 4.6)

Table 4.8

GENDER DIFFERENCES WITHIN GRADE LEVELS AND MATH ACHIEVEMENT

	4th male	4th female	5th male	5th female	6th male	6th female	7th male	7th female	8th male	8th female	total male	total female
partic.	25	25	31	22	18	34	25	26	23	21	122	128
mean	80.881	82.761	84.032	84.364	86.222	89.265	77.121	82.308	79.826	86.001	81.5	85.203
std dev	12.736	16.136	13.785	10.468	11.285	10.786	13.688	12.524	12.386	11.824	13.106	12.569

(SEE FIGURES 4.7 AND 4.8)

SUMMARY

To summarize, there were no significant differences in gender, grade level or an interaction with math anxiety. There were, however, significant differences in gender and math achievement and grade level and math achievement, but no significance in an interaction of the two.

Figure 4.6

Midterm Scores Grade Differences

Grades 4-8

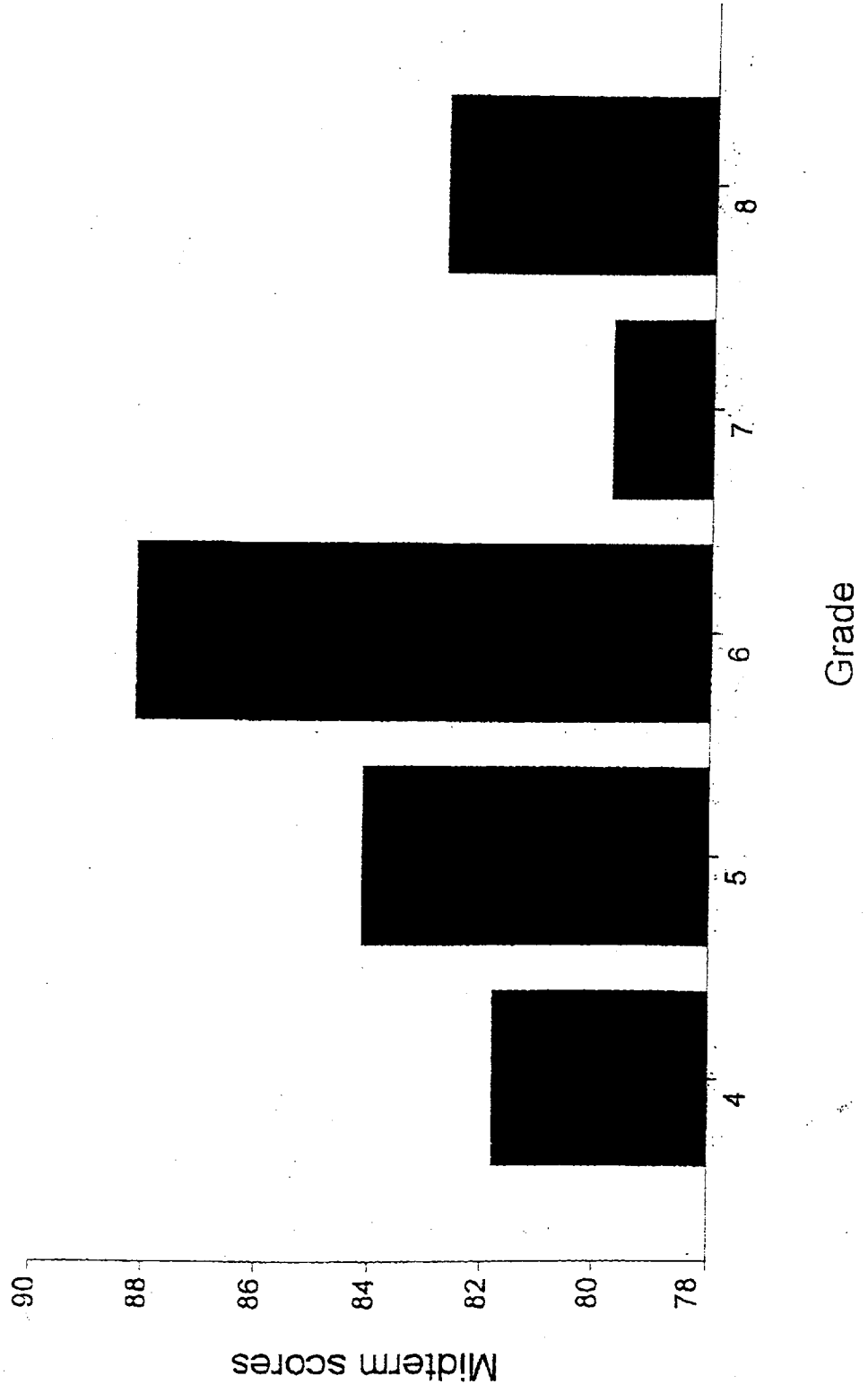


Figure 4.7

Gender and Grade Differences

Midterm scores

Grades 4-8

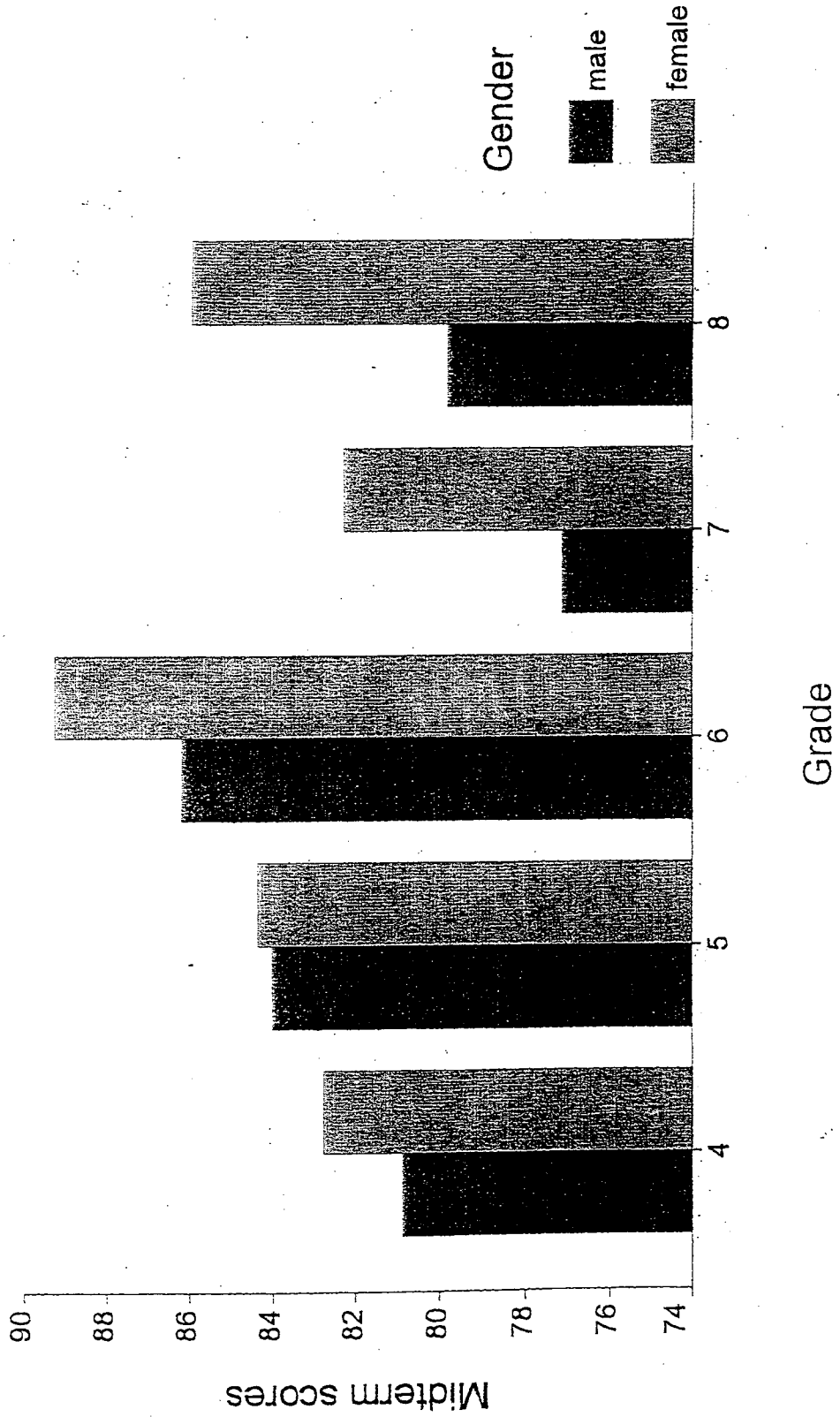
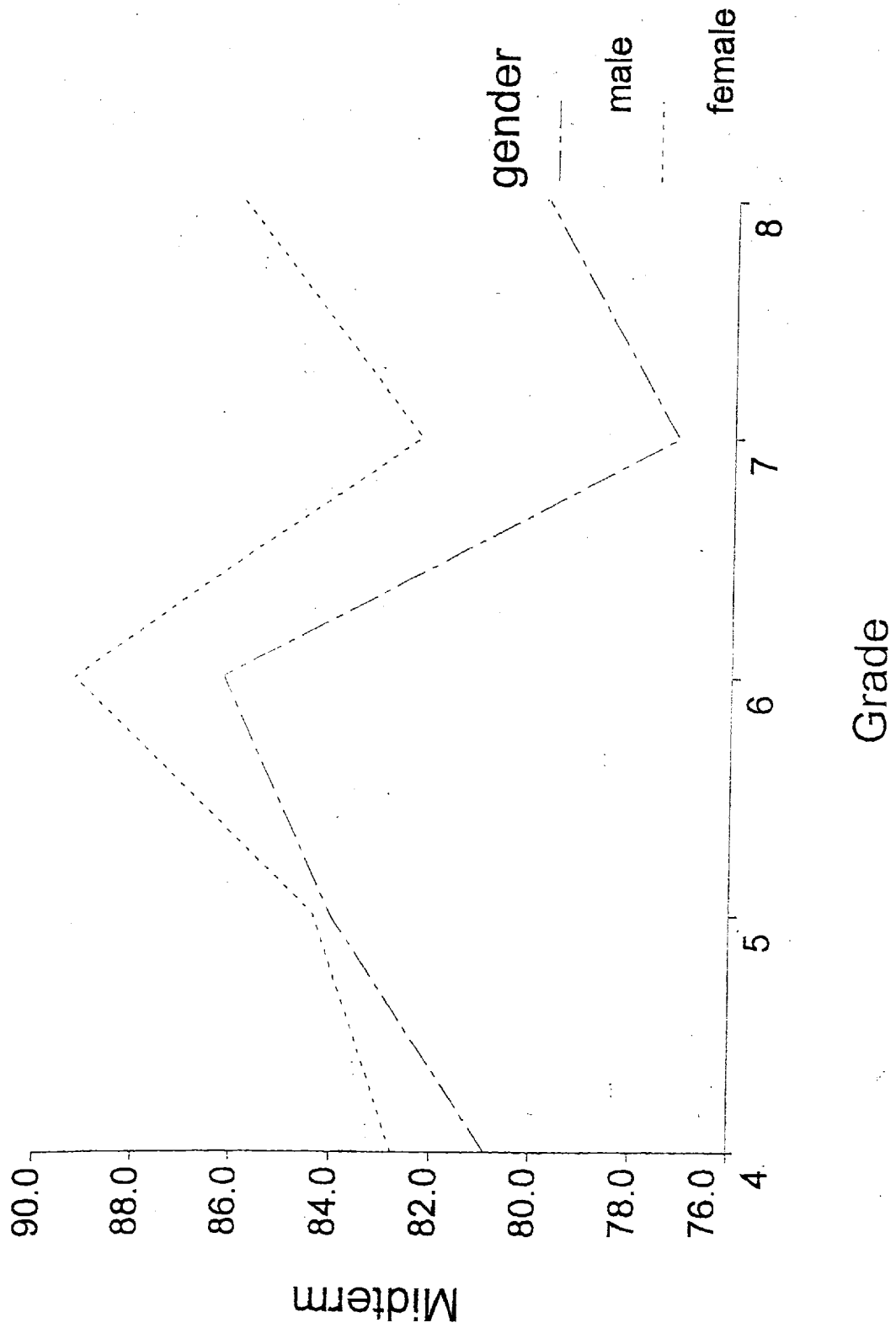


Figure 4.8

Gender differences and midterm scores

Grades 4-8



HYPOTHESIS #1 There will be no gender differences in math anxiety.	FAIL TO REJECT
HYPOTHESIS #2 There will be no grade level differences in math anxiety.	FAIL TO REJECT
HYPOTHESIS #3 There will be no interaction between gender and grade differences and math anxiety.	FAIL TO REJECT
HYPOTHESIS #4 There will be no gender difference in math achievement.	REJECT
HYPOTHESIS #5 There will be no grade level differences in math achievement.	REJECT
HYPOTHESIS #6 There will be no interaction between gender and grade differences and math achievement.	FAIL TO REJECT

Chapter Five: **Summary and Conclusions**

The subject of this study was used because of observations, many of which were supported by the literature, that males are more likely to enter mathematics-dominated career fields. The purpose of this study was to identify gender differences in mathematics anxiety as it is related to mathematics achievement. Based on previous research, it was expected that there would not be a significant gender difference overall in mathematics achievement, but that there would be a difference in mathematics anxiety. Specifically, it was expected that the females would have a higher mathematics anxiety than the males and that this difference would become larger in the older grades.

In this study, there were 250 participants (122 males and 128 females) in grades four through eight. Mathematics anxiety was measured using the Mathematics Anxiety Scale for Children (MASC), which is a 22-question, Likert-response survey. The sum of the individual's score yields that individual's anxiety rating. Mathematics achievement was measured by using the student's mathematics midterm score, which was coded to be paired with the same individual's anxiety score. A two-way Analysis of Variance was utilized to analyze the results.

The two-way ANOVA yielded results that were unexpected. First, there were no significant findings with math anxiety, in either gender, grade, or an interaction of both. Second, there were significant findings ($p < .05$) in mathematics achievement. There was a grade difference in mathematics achievement as well as a gender differences, in that the females performed better than the males.

Clearly, the results of this study were not what was expected as there were no differences in anxiety and the difference in achievement reflected that the *girls* outperformed the boys. While there is a diverse body of literature, with many contradicting results, there seemed to be support in several studies that girls tend to report having a higher math anxiety than boys, regardless of ability. In this study, that did not happen.

There are several reasons why the results of this study may have occurred in the way in which they did. First, in regard to math anxiety, because there has been much popular media attention on gender differences in mathematics, perhaps students responded in a way in which to contradict those reports. Therefore, perhaps females are aware that studies have indicated that males perform better and are more confident in math. In response, females may report, or indeed may feel, a heightened sense of confidence, and therefore less anxiety towards math.

Second, in regard to achievement in this particular study, math achievement was measured using the students' mathematics midterm scores. Therefore, it was not a standardized measure. The teacher in each grade level developed and administered their own examination. That there was a grade-level difference in midterm scores would certainly be expected, because each grade had a different exam, developed by a different teacher, and perhaps graded in a different manner. Again, based on the availability of the popular media regarding gender differences in mathematics ability, perhaps the teachers have become more sensitive to learning styles of females and have consequently adapted their teaching and testing style to meet the females' needs.

Finally, this study was designed to examine only measures of central tendency. The sample size of this study was not large enough to look only at the top five to ten percent of achievers to determine whether or not males were more prevalent in the higher end, as previous research has found. Much of the literature review on achievement differences indicated that there was little or none when looking at a total group.

However, there are often differences at the higher end of achievement, which become larger in the higher grade levels.

While there is a large body of research on this subject and related ones, the need for further research is certainly warranted. Based on the results of this study, future researchers may choose to increase sample sizes to look not only at the total group but also that of the high end of the distribution. Also, instead of just using a subjective method of measuring math anxiety (midterm scores), it is recommended to also use a standardized measure. Additionally, instead of just using a self-reported survey on math anxiety, perhaps math attitude surveys as well as feedback from teachers on students' mathematics confidence could be employed. Finally, it would be interesting to do a longitudinal study, following students from elementary school into high school and college, observing changes in their attitudes and performance in math, as well as career choices in math-related fields.

Although the results of this study did not reflect the expected results, there seem to be differences in individual's choices to enter certain career fields. If it is not anxiety or achievement, the factor contributing to fewer females considering math-related career fields needs to be explored.

References

- Benbow, Camilla Persson, & Stanley, Julian C. (1980). Sex differences in mathematical ability: fact or artifact? Science, 210, 1262-1264.
- Billier, Jerry (1996). Reduction of mathematics anxiety. Ringling School of Art and Design. (ERIC Document Reproduction Service No. ED 406 196)
- Campbell, Kathleen T. & Evans, Cay (1997). Gender issues in the classroom: a comparison of mathematics anxiety. Education, 117, 332-338.
- Campbell, Patricia B. & Storo, Jennifer N. (1996). Girls Are...Boys are...myths, stereotypes, and gender differences. Math and science for the co-ed classroom. Newton, MA: Women's Educational Equity Act Resource Center. (ERIC Document Reproduction Service No. ED 409 250)
- Caporrimo, Rosaria (1990). Gender, confidence, math: why aren't girls "where the boys are"? Boston, MA: Annual Meeting of the American Psychological Association. (ERIC Document Reproduction Service No. ED 334 074)
- Chiu, Lian-Hwang & Henry, Loren L. (1990). Development and validation of the Mathematics Anxiety Scale for Children. Measurement and Evaluation in Counseling and Development, 23, 121-127.
- Cohen, Ronald Jay & Swerdlik, Mark E. (1999). Psychological testing and assessment (4th ed.) Mountain View, CA: Mayfield Publishing Company.
- Eckmier, Janice & Bunyan, Ruth (1995). Equation for success. Thrust for Educational Leadership, 24, 40-42.
- Eldridge, Karen (mathcounts@nspe.org). (1999, September 30). Rates of gender participation in MathCounts. E-mail to Juliet McGinley (chachajul@aol.com).
- Fiore, Gregory N. (1999). Math-abused students: are we prepared to teach them? Mathematics Teacher, 92, 403-406.

Foss, Jeffrey E. (1996). Is there a natural sexual inequality of intellect? A reply to Kimura. Hypatia: A Journal of Feminist Philosophy, 11, (3), 22-33.

Gutbezahl, Jennifer (1995). How negative expectancies and attitudes undermine females' math confidence and performance: a review of the literature. (ERIC Document Reproduction Service No. ED 380 279)

Halpern, D. F. (1997). Sex differences in intelligence: implications for education. American Psychologist, 11 (3), 22-34.

Hammer, Christy & Dusek, R. Valentine (1995). Brain difference research and learning styles literature: from equity to discrimination. Feminist Teacher, 9, (2), 76-84.

Harper, Norma Wynn & Daane, C. Jelise (1998). Causes and reduction of math anxiety in preservice elementary teachers. Action in Teacher Education, 19 (4), 29-38.

Jensen, Rita A. & McMullen, David (1995). A study of gender differences in the math and science career interests of gifted fifth and sixth graders. New Orleans, LA: American Educational Research Association. (ERIC Document Reproduction Service No. ED 379 811)

Kimura, Doreen (1992). Sex differences in the brain. Scientific American, 267, 118-125.

Melancon, Janet G. (1993). How elementary school children think about mathematics. (ERIC Document Reproduction Service No. ED 356 246)

Pajares, Frank & Kranzler, John H. (1995). Self-efficacy beliefs and general mental ability in mathematical problem-solving. Contemporary Educational Psychology, 20, 426-443.

Pajares, Frank (1996). Self-efficacy beliefs and mathematical problem-solving of gifted students. Contemporary Educational Psychology, 21, 325-344.

Steele, Diana F. & Arth, Alfred A. (1998). Lowering anxiety in the math curriculum. The Education Digest, 63, 18-23.

Satake, Eiki & Amato, Philip P. (1995). Mathematics anxiety and achievement among Japanese elementary school students. Educational and Psychological Measurement, 55, 1000-1007.

Thorndike-Christ, Tracy (1991). Attitudes towards mathematics: relationships to mathematics achievement, gender, mathematics course-taking plans, and career interests. Washington, DC. (ERIC Document Reproduction Service No. ED 347 066)

Xitao, Fan, Chen, Michael, & Matsumoto, Audrey R. (1997). Gender differences in mathematics achievement: findings from the *National Educational Longitudinal Study of 1988*. The Journal of Experimental Education, 65, (3), 229-242.

Zanakis, Stelios H. & Valenzi, Enzo (1997). Student anxiety and attitudes in business statistics. Journal of Education for Business, 73, 10-16.

Zettle, Robert D. & Houghton, Lori L. (1998). The relationship between mathematics anxiety and social desirability as a function of gender. College Student Journal, 32, 81-86.