AN INVESTIGATION OF MATH ANXIETY AT KANSAS STATE UNIVERSITY

By

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CHAPTER ONE

INTRODUCTION AND STATEMENT OF THE PROBLEM

Introduction

At some point in their lives, most people have developed a fear or anxiety of some type. This might be a fear of flying, claustrophobia, or it might even be a student experiencing test anxiety. One common affliction amongst students is the fear of mathematics, better known as math anxiety. For some people, the mere mention of an area of mathematics, such as algebra, geometry, trigonometry, calculus, or even the term mathematics itself, can send them into a frenzy. No matter how intelligent these same people are in areas outside of mathematics, they generally feel incompetent when approached by a mathematician. They are positive that a normal conversation cannot take place, and usually find some way of excusing themselves. Over the past 20 to 30 years, several people have looked into this problem. Numerous articles have been written on the subject as well as at least three to four books. At the present time, there does not appear to be any clear cut cause or solution as to why people develop math anxiety. There are, however, many theories about the subject. The purpose of this report is to investigate the attitudes towards mathematics of some of the students enrolled in some lower level math courses at Kansas State University. For those students with

negative attitudes towards math, the cause (or causes) of their anxiety will also be investigated.

During the first four weeks of the fall semester of 1987, a survey[1] was administered to 498 students enrolled in some of the lower level math classes being offered at Kansas State University. The classes involved included four sections of MATH 010- Intermediate Algebra (Reference Numbers 13970, 14020, 14140, and 14160), five sections of MATH 100 - College Algebra (Reference Numbers 14270, 14350, 14410, 14440, and 14520), both sections of MATH 110 - Math, Its Form and Impact (Reference Numbers 14580 and 14590), two sections of MATH 205 - General Calculus and Linear Algebra (Reference Numbers 14720 and 14800), and both sections of MATH 308 - Topics in Mathematics for the Elementary School Teacher (Reference Numbers 15300 and 15310). Since MATH 010, MATH 100, and MATH 205 are offered at several different hours throughout the day, as well as on different days of the week, these particular reference numbers were arbitrarily chosen such that the survey would be administered to students enrolled in math at a variety of different times throughout the day and the week.[2] This time and day

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[1]See Appendix A for a copy of the survey that was given to the students.

[2]For a complete listing of the time periods for which the surveyed classes met, see Appendix B.

variation helps to eliminate the possibility that a certain result occurred just because of a characteristic which is common only to students who enroll in a math class offered at a certain time on a given day.

Once the surveys were administered, the results were used to determine information about the attitudes of these students towards math in relation to other factors, such as sex, class rank, and high school GPA. For those students who felt that they had math anxiety, the surveys also gave an indication as to what caused this anxiety. Also, grades for these classes were gathered to determine whether there was a relationship between the attitudes of the students and their success in the class.

Statement of the Problem

During the past 20 to 30 years, researchers have attempted to identify certain traits which are common to most people with math anxiety. Several traits, such as sex, parental attitudes, and race, have been tested against the attitudes of individuals towards math. For example, research has indicated that, in general, females tend to feel more anxiety towards math than males. Does this hold for the students that were surveyed at Kansas State? Are there other traits which are common to the students with math anxiety?

Some results which are expected to occur from the information gathered on the survey are:

1. Females tend to feel more anxious about math than males.

2. Females tend to have the same feelings towards math as their mother, while males generally have the same attitudes as their father, and

3. Blacks tend to have more of a negative attitude towards math than whites.

To determine what characteristics (including the 3 items listed above) tend to distinguish between the students with positive math attitudes and negative math attitudes, the following null hypotheses will be tested using the information gathered from the surveys:

1. There is no relationship between race and math anxiety.

2. There is no relationship between the colleges in which the students are enrolled in at Kansas State and math anxiety.

3. There is no relationship between any of the frequently recorded majors (frequency greater than or equal to 10) and math anxiety.

4. There is no relationship between the type of math class being taken and math anxiety.

5. There is no relationship between the size of the high schools attended by the surveyed students and math anxiety.

6. There is no relationship between the number of high school math classes taken by the student and math anxiety.

7. There is no relationship between sex and math anxiety.

8. There is no relationship between parental attitudes and student attitudes.

9. There is no relationship between high school class rank and math anxiety.

10. There is no correlation between the student's high school GPA and math anxiety.

11. There is no correlation between the student's college GPA and math anxiety.

12. There is no correlation between the student's grade in the math class and math anxiety.

Another test will also be conducted to test the validity of the student's response to item number 13 on the survey (Do you become anxious when you hear the word mathematics?) by comparing this response to the responses given on item number 14[3] (the Likert item dealing with attitudes about mathematics). This can be done by testing the following null hypothesis (hypothesis number 13):

13. There is no relationship between the student's responses to items 13 and 14 on the survey.

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[3]Suydam, Marilyn N., Evaluation in the Mathematics Classroom, ERIC Information Analysis Center for Science, Mathematics and Environmental Education, Columbus, Ohio, January 1974, pages 16-17.

CHAPTER TWO

LITERATURE REVIEW

During the 1970's and the 1980's, math anxiety, or math avoidance, has been the topic of many articles, as well as some books. The authors of these articles and books have mainly dealt with what causes math anxiety. What characteristics are common to a majority of the people with math anxiety? Most authors tend to quote one or more of the following as causes for math anxiety:

1. Females tend to experience more anxiety towards math then males.
2. Parental attitudes tend to influence the attitudes of their children.
3. Teacher attitudes (especially elementary teachers) tend to influence the attitudes of their students.

While these are not the only causes of math anxiety, they appear to be the dominant ones, and thus they will be the causes that are emphasized at this point. Items two and three tend to go together, and thus will be covered in one section. Some authors have also set up clinics to help eliminate math anxiety. These will also be emphasized.

Sex Differences and Math Anxiety

> "Male superiority in mathematics has been accepted as fact, almost without question, for many years. Certainly, if one observes adult use, many more males then females use mathematics daily, particularly advanced mathematics beyond arithmetic. One has only to look at engineering, medicine or any

science-related career, to confirm that males dominate math-related occupations."[4]

While math anxiety is not totally a female trait, most of the research has noted that there is a definite difference in the number of math anxious females as compared with math anxious males. Sheila Tobias, one of the leading authors in the field of math anxiety, states that:

> "Boys and girls may be born alike with respect to math, but certain sex differences in performance emerge early according to several respected studies, and these differences remain through adulthood. They are:
>
> 1. Girls compute better than boys (elementary school and on),
> 2. Boys solve word problems better than girls (from age thirteen on),
> 3. Boys take more math than girls (from age sixteen on), and
> 4. Girls learn to hate math sooner and possibly for different reasons."[5]

The main question, however, is why do these differences in performance occur? Tobias states at least three possible causes. They are:

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[4]Fennema, Elizabeth, "Women and Girls in Mathematics - Equity in Mathematics Education," Educational Studies in Mathematics, November, 1979, V10, N4, p. 389.

[5]Tobias, Sheila, "Who's Afraid of Math, and Why?", Atlantic Monthly, September 1978, V242, p. 64.

1. The amount of math learned and used at play,

2. Differences in male-female maturation, and

3. A genetic or hormonal difference between the sexes.[6]

It should be noted that major differences are first noted at the junior high level.

Consider the idea of the amount of math learned and used at play. Tobias, in several of her articles, as well as Elizabeth Fennema[7] both talk of differences in spatial abilities among the sexes. As children, boys are encouraged to play with blocks, take things apart, and then hopefully put them back together. They are also pushed into different sports, such as baseball and football. Each of these activities help to develop the spatial abilities and allow the males to develop the visualization ability required for mathematics. Girls, on the other hand, are encouraged to play with dolls, and thus are pushed into the role of happy homemaker or pin-up girl. Thus the play activities of boys appear to include more spatial components than the play activities of girls. Hence, by junior high, boys have developed the necessary visualization skills needed for some of

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[6]Tobias, Sheila, "Who's Afraid of Math, and Why?", Atlantic Monthly, September 1978, V242, p.64.

[7]Fennema, Elizabeth, "Sex Differences in Mathematics - Learning: Why???", The Elementary School Journal, December, 1974, V75, N3, p. 184.

the math problems found at that age. The girls are lacking them, and thus differences in abilities can result.

Maturation was also listed as a possible cause for differences in math performance. Tobias talks of research on sex differences performed by psychologist Eleanor Macoby.[8] Macoby noted that girls are generally more conforming, more suggestible, and more dependent upon the opinion of others than boys are. In a test given to third-graders, girls were found to be not nearly as willing to estimate, to make judgments about "possible right answers," or to work with systems they had never seen before. Tobias states:

> "As boys and girls grow older, girls become, under pressure, academically less competitive. Thus the falling off of girls' math performance between ages ten and fifteen may be because:
>
> 1. Math gets harder in each successive year and requires more work and commitment.
>
> 2. Both boys and girls are pressured, beginning at age ten, not to excel in areas designated by society to be outside their sex-role domains.

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[8]Tobias, Sheila, "Who's Afraid of Math, and Why?", Atlantic Monthly, September 1978, V242, p. 64.

3. Thus girls have a good excuse to avoid the painful struggle with math; boys don't."[9]

Each of these ideas can be traced back to the maturation patterns of the sexes.

The third cause Tobias states was a genetic or hormonal difference.[10] Since not all math underachievers or math avoiders are women, poor performance in math is unlikely to be due to some genetic or hormonal differences at birth. But Tobias feels that since the differences in math normally start appearing during the junior high age group, there might be some hormonal difference between the sexes at this time. Keep in mind that during the adolescence years, the students experience many changes. Thus puberty could be a cause of sex differences in math. A lot of the differences occurring at this time could also be an attitude problem. A common myth at this age is that the boys won't like a girl if the girl does better than they do in math. Although not all of this is directly related to genetic or hormonal differences, it does rely heavily on the maturity levels at those ages, which in turn rely on the genetics of the person.

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[9]Tobias, Sheila, "Who's Afraid of Math, and Why?", Atlantic Monthly, September 1978, V242, p.64.

[10]Ibid, p.64.

Edith Luchins suggests an idea which might eliminate some of the sex differences in mathematics. She feels that if female students could see role-models in mathematics, then some of the myths could be eliminated. Consider any collection of biographies of mathematicians. How many women would be included among the great mathematicians in history? Emmy Noether is generally the only one in the list. This leaves out such women mathematicians as Sophia Germain and Sonya Kovalevsky. While there are only a handful of famous women mathematicians, it is important to recognize their accomplishments. Unfortunately, very few people have been informed of the famous female mathematicians. Luchins believes that an increase in the awareness of the contributions of women mathematicians of the past could lead to a positive influence in the direction of females in mathematics for the future.[11]

John Ernest agrees that female mathematicians of the past should be acknowledged. Unfortunately, when people discuss the stereotype of a female mathematician, the name Emmy Noether is most often considered. While Emmy is probably one of the most famous female mathematicians, her traits were not what everyone would

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[11]Luchins, Edith H., "Sex Differences in Mathematics: How Not to Deal With Them", The American Mathematical Monthly, March, 1979, V86, N3, p. 161-162.

expect of a female. Ernest quotes from a eulogy of Emmy given by Hermann Weyl:

> "It was only too easy for those who met her for the first time, or had no feeling for her creative power, to consider her queer and to make fun at her expense. She was heavy of build and loud of voice, and it was often not easy for one to get the floor in competition with her. She preached mightily, and not as the scribes. She was a rough and simple soul, but her heart was in the right place. Her frankness was never offensive in the least degree. In every day life she was most unassuming and utterly unselfish; she had a kind and friendly nature. Nevertheless, she enjoyed the recognition paid her; she could answer with a bashful smile like a young girl to whom one had whispered a compliment. No one could contend that the Graces had stood by her cradle; but if we in Gottingen often chaffingly referred to her as 'der Noether' (with the masculine article), it was also done with a respectful recognition of her power as a creative thinker who seemed to have broken through the barrier of sex."[12]

Ernest feels that this problem of the "unfeminine" stereotype of the female mathematician is just one of many problems faced by the women considering mathematics as a career. Mary Gray does not limit her stereotyping to just women. She states:

> "The creative mathematicians of either sex may be unsocial and self-centered as well as having a great power of concentration and terrific tenacity comes as no surprise, but no one suggests that training women in these

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[12]Ernest, John, "Mathematics and Sex", The American Mathematical Monthly, October, 1976, V83, N8, p. 606.

traits should be undertaken to produce more women mathematicians."[13]

Gray seems to be suggesting that the stereotyping of female mathematicians does not have to be the pattern for the female mathematicians of today.

Parental and Teacher Attitudes Versus Children Attitudes

Sharon Wilhelm and Douglas Brooks performed a survey to see if there was a correlation between the attitudes of children (junior high age) and the attitudes of parents with respect to mathematics. The following research questions were investigated:

1. Is there a relationship between pupil attitudes toward mathematics and parental attitudes toward mathematics?
2. Are there differences in attitudes toward mathematics by sex?
3. Are there differences in attitudes toward mathematics by grade level?[14]

They found that mothers appear to have considerable influence on the anxiety toward mathematics felt by the daughter. The same appears to be true of the father/son relationship. Wilhelm and Brooks state that "it seems logical that as the adolescent is inclined to identify

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[13]Gray, Mary, "The Mathematical Education of Women", The American Mathematical Monthly, May, 1977, V84, N5, p.374.

[14]Wilhelm, Sharon; and Brooks, Douglas M., "The Relationship Between Pupil Attitudes Toward Mathematics and Parental Attitudes Toward Mathematics", Educational Research Quarterly, Summer, 1980, V5, N2, p.9.

with and imitate the behaviors and attitudes of salient sex role-models, the same sex parent could easily pass on a learned anxiety toward mathematics."[15] They feel that the mother greatly influences the pupils Self-Concept towards Math for both sexes in the low ability groups, but this diminishes in higher ability groups. As for the Value of Mathematics, fathers of low ability daughters tended to perceive mathematics as having little value. The daughters agreed. The fathers of higher ability daughters tended to share their daughters enjoyment of math, whereas fathers of higher ability sons did not share the enjoyment of their sons. Wilhelm and Brooks felt that comparisons of parental and pupil perceptions of math could shed considerable light on the attitudes and possibly achievement of pupils in mathematics.

Luchins found that parental and teacher attitudes prompted math anxieties in the females she surveyed. She found that more women than men could recall being discouraged from doing math by family and friends. Comments such as: "My mother worried that boys wouldn't like me or date me" or "My father thought I wasn't serious enough to be a mathematician" kept popping up.

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[15]Wilhelm, Sharon; and Brooks, Douglas M., "The Relationship Between Pupil Attitudes Toward Mathematics and Parental Attitudes Toward Mathematics", Educational Research Quarterly, Summer, 1980, V5, N2, p.9.

Luchins also found that three times as many women as men were discouraged by teachers or advisors. Believe it or not, Luchins found the difference at the graduate level to be the most marked difference. She heard comments such as: "The teacher expected less of girls"; "My teacher paid attention only to the boys"; "My counselor said girls didn't do well in math"; or "My advisor asked why I wasn't home having babies." Sexist reasons for the discouragement were given by a fifth of the women Luchins surveyed, but none of the men she surveyed gave this for a reason.[16]

Over the years, teachers and parents have often expected their girls to be nonmathematical. Tobias states that parents, peers, and teachers tend to forgive a girl when she does badly in math at school, and encourage her to do well in other subjects. If a female succeeds at math, she usually attributes it to luck, and when she fails, she blames herself and tends to explain it by saying "I'm not good at math." Boys, on the other hand, tend to explain a failure in math as a lack of effort.[17]

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[16]Luchins, Edith H., "Sex Differences in Mathematics: How Not to Deal With Them", The American Mathematical Monthly, March 1979, V86, N3, p.162.

[17]Tobias, Sheila, "Who's Afraid of Math, and Why?", Atlantic Monthly, September, 1978, V242, p.65.

Teachers have also been the cause behind some of the anxieties in females. Ernest surveyed a small sample of elementary and high school teachers. He found that most teachers, even if they are females who excel in math, tend to believe that boys do better in math and science than girls. Children can sense these attitudes and hence this could be one of the leading causes to the myth that boys are better than girls in math.[18]

Another possible cause of math anxiety in students is that they see their elementary school teacher as having math anxiety. Bonnie Donady and Tobias have found that some elementary education majors choose this field because few mathematics courses were required. That is, these future elementary school teachers have math avoidance, a symptom of math anxiety. No matter how excellent a teacher might be, if that teacher has math anxiety, they must face up to it, and avoid spreading the disease to their students.[19]

Tobias blames the classroom for some of the other anxieties found in people. She describes a typical math classroom as being fraught with ego-threatening consequences. This includes going to the blackboard to reveal one's "stupidity" in front of everyone else,

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[18]Ernest, John, "Mathematics and Sex", The American Mathematical Monthly, October 1976, V83, N8, p.599.

[19]Donady, Bonnie; and Tobias, Sheila, "Math Anxiety", Teacher, November, 1977, V95, N3, p.71.

taking timed tests which puts pressure and tension on the student, an emphasis on the right answer with no room for discussion or debate, and a feeling that the mind is blank. People also find that the mode of explanation in math is generally unclear and unhelpful. Tobias found that some of the most frequently remembered frustrations had to do with actual or perceived ambiguity in the language being used in class, making it difficult to translate various mathematical ideas into words or pictures.[20] To see a possible ambiguity in math, Tobias suggests one consider the term zero. In kindergarten, students learn that zero is "nothing"; in first grade, zero becomes a "place-holder"; and by fifth grade, students have been taught that division by zero is not possible.[21]

Clinics for People with Math Anxiety

While there are several clinics, or workshops, set up across the United States to help eliminate math anxiety, two particular clinics tend to be the ringleaders. Dr. Stanley Kogelman and Dr. Joseph Warren have set up a clinic in New York City called Mind Over Math, while Bonnie Donady and Sheila Tobias run the

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[20]Tobias, Sheila, "Managing Math Anxiety", The Education Digest, December, 1978, V44, N4, p.39-40.

[21]Tobias, Sheila, "Math Anxiety", Ms. Magazine, September, 1976, V5, N1, p.56.

Wesleyan Math Clinic in Middletown, Connecticut. Some other programs are listed in the article "Math Anxiety" by Donady and Tobias.[22]

Kogelman and Warren list twelve items which are common myths in the field of mathematics. They are:

1. Men are better in math than women,
2. Math requires logic, not intuition,
3. You must always know how you got the answer,
4. Math is not creative,
5. There is a best way to do a math problem,
6. It's always important to get the answer exactly right,
7. It's bad to count on your fingers,
8. Mathematicians do problems quickly, in their heads,
9. Math requires a good memory,
10. Math is done by working intensely until the problem is solved,
11. Some people have a "Math Mind" and some don't, and
12. There is a magic key to doing math.[23]

Unfortunately, most people who have problems with math, cite one of the above as the cause. But chapter 2 of

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[22]Donady, Bonnie; and Tobias, Sheila, "Math Anxiety", Teacher, November 1977, V95, N3, p.74.

[23]Kogelman, Dr. Stanley, and Warren, Dr. Joseph, Mind Over Math, McGraw-Hill Book Company, New York, 1978, p.30-43.

Kogelman and Warren's book is devoted to pointing out the errors behind each of these ideas.[24] Kogelman and Warren have set up their Mind Over Math clinic to help society eliminate these myths. Through this clinic, math anxious people are taught to overcome these myths, and hopefully their fear of mathematics. The clinic is a consulting service which offers programs that attempt to reduce math anxiety. Warren had found that allowing people an opportunity to discuss their feelings about math enabled them to learn math more quickly. This is used as part of their therapy procedures.[25]

In a similar setting, Donady and Tobias have set up a clinic to help reduce math anxiety. Donady and Tobias have each of their students from this clinic give an oral mathematics autobiography, in which the students give causes for their math anxieties.[26] Since a majority of their students are females, a lot of the excuses given deal with the myth that math is a male domain, and hence boys are supposed to do better than girls, i.e. males are just naturally better at math than

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[24]Kogelman, Dr. Stanley, and Warren, Dr. Joseph, Mind Over Math, McGraw-Hill Book Company, New York, 1978, p.30-43.

[25]Kogelman, Dr. Stanley; and Warren, Dr. Joseph, Mind Over Math, McGraw-Hill Book Company, New York, 1978, p.XI.

[26]Donady, Bonnie; and Tobias, Sheila, "Math Anxiety", Teacher, November, 1977, V95, N3, p.74.

females. Other common responses are lack of self-confidence, parental attitudes and actions, and teacher attitudes and actions. For example, a child (especially girls) notices that his/her mother has trouble balancing the checkbook, or that after sixth grade Mom helps with all the homework but math. Father takes over the math. These two little actions lead the children to believe the myth that men are better than women in math.

These clinics might not cure everyone of math anxiety, but they do seem to alleviate some of the problem. Both clinics feed on the attitudes of their clients more than their abilities. In her book, Tobias quotes the Math Anxiety Bill of Rights by Sandra L. Davis. It is:

> "I have the right to learn at my own pace and not feel put down or stupid if I'm slower than someone else.
>
> I have the right to ask whatever questions I have.
>
> I have the right to need extra help.
>
> I have the right to ask a teacher or TA for help.
>
> I have the right to say I don't understand.
>
> I have the right not to understand.
>
> I have the right to feel good about myself regardless of my abilities in math.
>
> I have the right not to base my self-worth on my math skills.
>
> I have the right to view myself as capable of learning math.

I have the right to evaluate my math instructors and how they teach.

I have the right to relax.

I have the right to be treated as a competent adult.

I have the right to dislike math.

I have the right to define success in my own terms."[27]

This Bill of Rights appears to summarize the main purpose of the math anxiety clinics.

Summary

While sex differences, parental attitudes, and teacher attitudes are only three causes of math anxiety, they are a starting point in trying to decide how to correct the problem. The next question, and probably the most important question, is what happens if there is no attempt to correct and "stop" math anxiety? Tobias, in most of her articles, also discusses this thought. She states that math anxiety becomes an "I can't" syndrome.[28] Once a person has become frightened of math, they begin to fear all manners of computations. This could lead to a defeatist attitude amongst people. Another possible downfall of mathematics anxiety or

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[27]Tobias, Sheila, Overcoming Math Anxiety, Houghton Mifflin Company, Boston, 1978, p.236-7.

[28]Tobias, Sheila, "Math Anxiety", Ms. Magazine, September, 1976, V5, N1, p.57.

mathematics avoidance is that students limit their career options by avoiding math. Tobias refers to a survey completed by Lucy Sells in 1973. She surveyed the entering freshman class at Berkeley that year on their high school math background. Of the incoming freshman, she found that 57% of the entering males had four years of high school math, while only 8% of the females did. Thus 92% of the women were not eligible to take calculus or intermediate level statistics. This meant that 92% of the women entering Berkeley in 1973 were, because of mathematics, only eligible to major in five out of the twenty majors being offered at Berkeley at that time. Note that earlier it was mentioned that some people work towards a major in elementary education because of the lack of math requirements for the degree. This was one of the five possible majors left open to these women at Berkeley. The other four were the humanities, music, social work, and guidance and counseling.[29] Thus a lack of preparation in math can lead to a lack of choice in careers.

For further reading, it should be noted that at least two papers have been developed in the area of math anxiety with the sole purpose of listing a bibliography of articles on math anxiety. Roger Berebitsky dealt

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[29]Tobias, Sheila, "Math Anxiety", Ms. Magazine, September, 1976, V5, N1, p.56-57.

with the area of math anxiety for his master's thesis. After a brief introduction and statement of the problem, he defined a few of the terms common to the area of math anxiety. The majority of his thesis, however, was spent in summarizing articles on math anxiety which have been written between 1975 and 1985.[30] Marilyn N. Suydam and Vicky Kirschner authored a paper for the National Institute of Education in Washington D.C. which consists only of a large bibliography of articles on math anxiety.[31]

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[30]Berebitsky, Roger D., "An Annotated Bibliography of the Literature Dealing with Mathematics Anxiety", Masters Thesis, Indiana University, 1985.

[31]Suydam, Marilyn N.; and Kirschner, Vicky, "Selected References on Mathematical Anxiety, Attitudes, and Sex Differences in Achievement and Participation", National Institute of Education, Washington D.C., 1980.

CHAPTER THREE

PROCEDURES FOR STUDY

Survey Information

As was stated earlier, a survey (see Appendix A) was administered in the fall of 1987 to a group of Kansas State students enrolled in some of the lower-level math classes. The surveys were designed to gather some background information about each of the surveyed students, as well as information concerning their attitudes about math. Items such as year in college, age, sex, race, major, high school GPA, college GPA, rank in high school, size of high school, and high school courses taken along with grades were gathered for background information. Their attitudes towards math were gathered by looking at items 13 to 17 on the survey. Items 13, 14, and 17 dealt strictly with the student's attitudes, whereas items 15 and 16 dealt with parental attitudes. At the end of the semester, the student's final grade was also obtained for the respective math classes.

Coding

In order to run the statistics for the project, the information gathered from the surveys had to be changed into some form the computer could use. Thus, each response on the survey was changed to a numerical value

and placed into the computer.[32] Three other responses- grade in class, college to which the student belongs, and number of years of high school math - were also included in the coding.[33]

In doing the coding, some decisions needed to be made. The following conventions were adopted in order to allow the coding to be consistent. Under the category of Race, a response of Italian was considered white; a response of Afro-American was considered black; and a response of Asian-American was considered Asian or Pacific Islander. On item 12, Vocational Math and Consumer Math were considered to be Business Math classes, whereas Advanced Math included such responses as Trigonometry, Trigonometry and Analytics, Trigonometry/Calculus, Algebra/Trigonometry, Applied Geometry/Trigonometry, College Algebra/Trigonometry, Algebra III, College Algebra, Introduction to College Algebra, Pre-Calculus, Pre-College Math, and Analytical Geometry. Classes which were considered as other math classes included courses such as Probability and Statistics, General Algebra, Algebra Review, Introduction to Algebra, Pre-Algebra, College Prep I,

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[32]See Appendix C for the actual coding procedure used for the survey.

[33]See Appendix D for the actual coding for each survey as it was typed into the computer.

College Prep II, Calculus I, Calculus II, Math for College Bound Seniors, Analysis, Liberal Arts Math, Geometry II, and Computer Math. Also, if a student gave a high school GPA greater than 4.0, it was coded as if the high school GPA was not available.

Decisions also needed to be made in coding Item 17. The responses given on Item 17 were divided into seven categories:

1. I had a teacher who disliked math, and discouraged me;
2. My parents don't think it is important;
3. I can't seem to understand the concepts, and this discourages me;
4. I had a bad experience with a math class;
5. Math is a male-dominated field and I'm a female;
6. Math is too exact and we must always get the right answer; and
7. Miscellaneous responses.

After reading through the student's responses, they were placed in one or more of the categories. The following gives an idea of what type of responses were placed into each category. Responses involving problems with a teacher when the student was younger (elementary teachers) were placed in category 1. Category 2 included responses concerning not being pushed into enough math classes, not getting help on homework at

home, and parents having a poor math background. Under the 3rd category, items such as getting lost in math, feeling uncomfortable, teachers expecting a certain method for doing a problem, lack of patience, confusion, not enough individual attention to learn the procedures, frustration, missing a few key procedures, being poor with specific areas of math, being unsure, understanding in class but forgetting at home, and math moving too fast were included. The 4th category included responses involving items such as bad teachers (i.e. teachers not willing to help, teachers who were poor lecturers-boring, or teachers not stating reasons for why things are done in a certain manner), having to explain problems in front of the entire class, and not getting along with the teacher. Category 5 was self-explanatory and nothing unusual was placed there. Responses such as having trouble getting the right answer, not getting the answer quickly, no room for mistakes, fear of the wrong answer, getting stuck and giving up, losing a sign or a number, stressing precision, being either right or wrong, and math is too black and white fell into category 6. In the final category, such items as the manner in which problems are written, only requiring two years of high school math, not taking enough math in high school (poor background), feeling math was not important, hating math, not paying attention, test

anxiety, waiting too many years between math classes, too much work (homework all the time), disliking the memorization of formulas, taking too much time, and problems don't deal with everyday life situations were included.

Objectives

The main purpose of this study is to evaluate the attitudes of some of the students enrolled in lower-level math classes at Kansas State. By using the coding obtained from the surveys, the null hypotheses stated in Chapter One were tested. From these tests, conclusions can be formed concerning what are some common traits amongst a majority of the students who have math anxiety. Responses to Item 17 on the survey can also be utilized in determining the causes of math anxiety.

Analyzing the Data

The statistics needed to test the null hypotheses stated in Chapter One were calculated using the SPSS^X system available at Kansas State.

Variables

The variables listed in the following table were used in running the statistics. A brief description also accompanies the variables.

Variable	Description
CLASS	Math class in which the student was enrolled.
SEX	Sex of the student.
RACE	Race of the student.
MAJOR	Specific major of the student.
HSGPA	High school GPA of the student.
CGPA	College GPA of the student.
RANK	High school class rank of the student.
SIZE	Size of the high school the student attended.
ANXIETY	Student's response to Item 13 (student's math anxiety).
MOM	Student's response to Item 15 (mom's attitude).
DAD	Student's response to Item 16 (dad's attitude).
GRADE	Student's grade in the math class.
COLLEGE	Particular college (Agriculture, Business, etc.) to which the student belongs.
YEARMATH	Number of high school math classes taken by the student.

CHAPTER FOUR

STATISTICAL ANALYSIS

Background Information

In order to test the thirteen null hypotheses listed in Chapter One, two general statistics were used. Hypotheses 1-9 and 13 were tested by using the Chi-Squared Test for Independence (or Pearson Chi-Squared Test for Independence), while hypotheses 10-12 were tested by using the Pearson Product-Moment Correlation. For each test, the alpha-level was set at .05. This means that the probability of making a type I error (rejecting a true null hypothesis) is .05.

While the initial population was set at 498, the population for each of these tests will vary. This variation is due to the fact that on some surveys certain responses had to be eliminated. The reason for the elimination varied from question to question, but involved reasons such as a student not answering a specific question or a student may have marked more than one answer when only one was appropriate.

Chi-Squared Test for Independence

The Chi-Squared Test for Independence is used to obtain a test of the null hypothesis that two variables are independent. In some cases, the test might be conducted by controlling yet a third variable. Normally, there are two main parts to the results of the

statistic - a contingency table and the actual chi-squared value, which includes the number of degrees of freedom for the test and a significance-level.

A contingency table is basically a matrix which represents the breakdown of the subjects in terms of two or more variables. For example, if a chi-squared test were conducted to test the independence of sex and math anxiety, each subject would be placed into one of the following four categories:

1. A male with math anxiety,
2. A male without math anxiety,
3. A female with math anxiety, and
4. A female without math anxiety.

When using the SPSS^X system, the computer will also state a row percentage, column percentage, and total percentage for each category, as well as row and column totals.

The actual chi-squared value is computed by using the values found in the contingency table (observed values), as well as some "expected" values. To calculate the expected value for each category, the following formula is used:

$$E(A_i \text{ and } B_j) = n\ p(A_i)\ p(B_j)$$

where A_i represents the level of the first variable, B_j represents the level of the second variable, n represents the size of the population, $p(A_i)$ represents the probability that A_i will occur, and $p(B_j)$

represents the probability that B_j will occur. The actual formula is given by

$$\chi^2 = \sum_{k=1}^{a} \frac{(O_k - E_k)^2}{E_k}$$

where a is the number of different categories in the contingency table (i.e. for a two-by-two contingency table, there are 4 categories), O_k is the observed value for the k^{th} category, and E_k is the expected value for the k^{th} category. To calculate the degrees of freedom (df), the following formula is applied:

$$df=(r-1)(c-1)$$

where r represents the number of rows in the contingency table, and c represents the number of columns in the contingency table. The significance-level (p) is found by using a table and the above values. In order to record a significant test (i.e. the two variables are dependent upon each other to some degree), the p value must be less than the alpha-level which was set prior to the test. For this project, the alpha-level was .05.

When a chi-squared test for independence is significant, another statistic is computed to measure the strength of the association between the two variables. Normally, this is done by computing a Cramer's V value or a phi value. For this study, the Cramer's V value was computed. The formula for

estimating Cramer's V is:

$$V = \sqrt{\frac{\chi^2}{n(s-1)}}$$

where n is the size of the population, and s is the smaller of r and c (r and c were defined above). The value of V ranges from 0 to 1 with 0 indicating complete independence and 1 indicating complete dependence. It should be noted that a value for V can be computed even if the chi-squared test is not significant. In this case, however, a value for V greater than 0 is probably due to chance and not an association between the two variables.

As was stated earlier, the chi-squared test for independence was used to test hypotheses 1-9 and 13. The results of those tests follow. Note that a contingency table and a Cramer's V value will only be included if a significant chi-squared value was found.

Recall from Chapter One that the first null hypothesis was that there is no relationship between race and math anxiety. Due to the fact that the student's surveyed were predominately white, it was necessary to divide the students into 2 races: whites and non-whites. Even by doing this, the numbers in each category were still quite diverse (457 whites to 35 non-whites). A chi-squared value of .20283 with 1 degree of freedom and p=.6524 was calculated. While this is not

significant and the null hypothesis should be retained, the large difference between the numbers in each category might be deceptive. Further research, where the population contains a better distribution amongst the different races, might be warranted.

The second null hypothesis listed was that there is no relationship between the colleges in which the students are enrolled in at Kansas State and math anxiety. Seven different colleges - Agriculture, Architecture, Arts and Sciences, Business, Education, Engineering, and Home Economics - were represented. For this test, a chi-squared value of 10.96137 with 6 degrees of freedom and p=.0896 was computed. Since p>.05, the test is not significant and the null hypothesis should be retained. It should be noted that further research might again be warranted here, because the p-value is not that much larger than alpha.

Hypothesis number three was that there is no relationship between any of the frequently recorded majors (frequency greater than or equal to 10) and math anxiety. By looking at Item 7 on the survey, nine different majors were found to have a frequency of at least ten. They were: Agricultural Economics, Pre-Veterinary Medicine, Journalism and Mass Communications, Business Administration (undeclared), Business Pre-Professional, Accounting, Management, Marketing, and

Elementary Education. When testing these nine majors against math anxiety, a chi-squared value of 18.08869 with 16 degrees of freedom and p=.3187 was calculated. This indicates that there is no significant relationship between the different majors and math anxiety. The null hypothesis should be retained.

There is no relationship between the type of math class being taken and math anxiety was the fourth null hypothesis. For this null hypothesis, the contingency table found in Table 4-1 was formed. A chi-squared value of 14.09829 with 4 degrees of freedom and p=.0070 was calculated. Since .0070 is less than the alpha-level of .05, the null hypothesis should be rejected. The Cramer's V value calculated for this significant chi-squared test is .16894. Since this value is closer to 0 than to 1, it indicates a slight relationship between ANXIETY and CLASS. In analyzing Table 4-1, a larger percentage of the students in Math, It's Form and Impact and Topics in Mathematics for the Elementary School Teacher exhibit more math anxiety than the remaining three courses. Students in Intermediate Algebra and College Algebra exhibit the least math anxiety, while students in General Calculus and Linear Algebra are split with a little more than 50% of the students exhibiting math anxiety. The fact that Topics in Mathematics for the Elementary School Teacher was one

Table 4-1
Contingency Table for Testing the
Independence of ANXIETY with CLASS

Count Row Percentages Column Percentages Total Percentages		ANXIETY Yes	 No	Row Total
CLASS	Intermediate Algebra	38 38.4 16.6 7.7	61 61.6 23.0 12.3	99 20.0
	College Algebra	60 38.5 26.2 12.1	96 61.5 36.2 19.4	156 31.6
	Math, It's Form and Impact	56 54.9 24.5 11.3	46 45.1 17.4 9.3	102 20.6
	General Calculus and Linear Algebra	33 50.8 14.4 6.7	32 49.2 12.1 6.5	65 13.2
	Topics in Mathematics for the Elementary School Teacher	42 58.3 18.3 8.5	30 41.7 11.3 6.1	72 14.6
	Column Total	229 46.4	265 53.6	494 100.0

of the classes where more students exhibited math anxiety reinforces the fact that a lot of the elementary teachers have math anxiety and could possible transmit this to their students.

The fifth null hypothesis was that there is no relationship between the size of the high schools attended by the surveyed students and math anxiety. Size of high schools was divided into four categories: schools less than 500 students, schools with 500 to 1000 students, schools with 1000 to 1500 students, and schools with more than 1500 students. A chi-squared value of 6.14202 with 3 degrees of freedom and p=.1049 was calculated. Since .1049>.05, the null hypothesis should be retained. Thus, there is no relationship between SIZE and ANXIETY. As with the second null hypothesis, further research might be warranted since the p-value is not that much larger than alpha.

There is no relationship between the number of high school math classes taken by the student and math anxiety was the sixth null hypothesis. A contingency table for this hypothesis appears in Table 4-2. A chi-squared value of 18.58563 with 6 degrees of freedom and p=.0049 was computed. Since p=.0049 is less than the alpha value of .05, the decision should be to reject the null hypothesis. Thus, a Cramer's V value should be calculated. It was found to be .19456. This indicates

Table 4-2
Contingency Table for Testing the
Independence of ANXIETY with YEARMATH

Count Row Percentages Column Percentages Total Percentages		ANXIETY Yes	 No	Row Total
YEARMATH	1	21 67.7 9.3 4.3	10 32.3 3.8 2.0	31 6.3
	2	52 60.5 23.0 10.6	34 39.5 12.8 6.9	86 17.5
	3	71 41.3 31.4 14.5	101 58.7 38.1 20.6	172 35.0
	4	55 41.0 24.3 11.2	79 59.0 29.8 16.1	134 27.3
	5	23 39.0 10.2 4.7	36 61.0 13.6 7.3	59 12.0
	6	3 37.5 1.3 .6	5 62.5 1.9 1.0	8 1.6
	7	1 100.0 .4 .2		1 .2
Column Total		226 46.0	265 54.0	491 100.0

a slight relationship between the number of high school classes taken and math anxiety. Table 4-2 indicates that the students with one or two high school math classes exhibited more math anxiety than those students with three to six high school math classes. The lone student that took seven high school level math classes and indicated a fear of mathematics is probably a very rare person. Because there is only one person in this category, there is not enough information to make any judgments. If this person is eliminated from the test, the new contingency table does not change much from Table 4-2. The new chi-squared value of 17.41689 with 5 degrees of freedom and p=.0038 is still significant at the .05 level. The new Cramer's V is .18853, which still indicates a slight relationship.

Hypothesis number seven states that there is no relationship between sex and math anxiety. Table 4-3 shows the contingency table for this test. The calculated chi-squared value of 9.61753 with 1 degree of freedom and p=.0019 is significant at the .05 level. Thus, the null hypothesis should be rejected. A Cramer's V value of .14376 was calculated indicating a slight relationship between ANXIETY and SEX. Analyzing the table, males exhibited less anxiety than females. This reinforces the information gathered by previous researchers.

Table 4-3
Contingency Table for Testing the
Independence of ANXIETY with SEX

Count Row Percentages Column Percentages Total Percentages		ANXIETY Yes	 No	Row Total
SEX	Male	86 38.4 37.7 17.4	138 61.6 52.1 28.0	224 45.4
	Female	142 52.8 62.3 28.8	127 47.2 47.9 25.8	269 54.6
	Column Total	228 46.2	265 53.8	493 100.0

The eighth hypothesis stated that there is no relationship between parental attitudes and student attitudes. To test this hypothesis, a higher order chi-squared test was performed. A higher order chi-squared test means that a third variable is controlled while a comparison of two other variables is conducted. The actual null hypothesis being tested is:

> There is no relationship between a mother's attitude towards math and a father's attitude towards math while controlling the student's attitude towards math.

This test led to two chi-squared values - one for those students with math anxiety and one for those students without math anxiety. While both values were not significant at the .05-level, both contingency tables have been included anyway. Table 4-4 is the contingency table for testing the independence of MOM with DAD for students with math anxiety, while Table 4-5 is for those students without math anxiety. For those students who felt they have math anxiety, the chi-squared value for MOM versus DAD is 25.31126 with 16 degrees of freedom and p=.0645. This is not significant at the .05 level, but the small p-value indicates that further research is warranted. If the contingency table, Table 4-4, is analyzed, it should be noted that students with math anxiety tend to rate both of their parents as loving or liking math (19.1%) more frequently than rating both of their parents as disliking or hating math (5.5%). For

Table 4-4
Contingency Table for Testing the
Independence of MOM with DAD for
Students with Math Anxiety

Count Row Percentages Column Percentages Total Percentages		DAD Loves	Likes	Neutral	Dislikes	Hates	Row Total
MOM	Loves		5 83.3 5.4 2.3			1 16.7 12.5 .5	6 2.7
	Likes	13 22.4 35.1 5.9	24 41.4 26.1 10.9	14 24.1 23.0 6.4	7 12.1 31.8 3.2		58 26.4
	Neutral	11 11.8 29.7 5.0	38 40.9 41.3 17.3	34 36.6 55.7 15.5	6 6.5 27.3 2.7	4 4.3 50.0 1.8	93 42.3
	Dislikes	6 15.4 16.2 2.7	18 46.2 19.6 8.2	9 23.1 14.8 4.1	4 10.3 18.2 1.8	2 5.1 25.0 .9	39 17.7
	Hates	7 29.2 18.9 3.2	7 29.2 7.6 3.2	4 16.7 6.6 1.8	5 20.8 22.7 2.3	1 4.2 12.5 .5	24 10.9
	Column Total	37 16.8	92 41.8	61 27.7	22 10.0	8 3.6	220 100.0

Table 4-5
Contingency Table for Testing the
Independence of MOM with DAD for
Students without Math Anxiety

Count Row Percentages Column Percentages Total Percentages		DAD Loves	Likes	Neutral	Dislikes	Hates	Row Total
MOM	Loves	4 28.6 10.5 1.6	3 21.4 2.5 1.2	3 21.4 4.4 1.2	3 21.4 14.3 1.2	1 7.1 20.0 .4	14 5.6
	Likes	13 18.6 34.2 5.2	41 58.6 34.2 16.3	14 20.0 20.6 5.6	2 2.9 9.5 .8		70 27.8
	Neutral	9 8.7 23.7 3.6	46 44.7 38.3 18.3	38 36.9 55.9 15.1	8 7.8 38.1 3.2	2 1.9 40.0 .8	103 40.9
	Dislikes	9 17.6 23.7 3.6	22 43.1 18.3 8.7	12 23.5 17.6 4.8	7 13.7 33.3 2.8	1 2.0 20.0 .4	51 20.2
	Hates	3 21.4 7.9 1.2	8 57.1 6.7 3.2	1 7.1 1.5 .4	1 7.1 4.8 .4	1 7.1 20.0 .4	14 5.6
	Column Total	38 15.1	120 47.6	68 27.0	21 8.3	5 2.0	252 100.0

those students who felt they do not have math anxiety, the chi-squared value for MOM versus DAD is 29.88132 with 16 degrees of freedom and p=.0186. This is significant at the .05 level, and the Cramer's V value is .17217. By analyzing Table 4-5, a slight relationship can be found in that students without math anxiety tend to rate both of their parents as loving or liking math (24.3%) more frequently than rating both of their parents as disliking or hating math (4.0%). Because of the insignificant result for those students with math anxiety, a significant relationship cannot be recorded. The data indicates that further research into the relationship between parental attitudes and student attitudes is warranted.

Hypothesis nine states that there is no relationship between high school class rank and math anxiety. For this test, a chi-squared value of 2.06022 with 2 degrees of freedom and p=.3570 was calculated. Since .3570>.05, this is not a significant chi-squared value. Thus, the null hypothesis should be retained indicating that there is no relationship between RANK and ANXIETY.

The final hypothesis to be tested using a chi-squared test for independence is the thirteenth hypothesis. It states there is no relationship between the student's responses to items 13 and 14 on the

survey. To test this hypothesis, it was necessary to transform the responses to the 26 items on number 14 into a single response. In order to do this, the 26 items on number 14 were divided into two groups - items reflecting positive math attitudes (b, c, f, h, l, m, o, p, r, t, v, x, and y) and items reflecting negative math attitudes (a, d, e, g, i, j, k, n, q, s, u, w, and z). The items reflecting positive attitudes were recoded so that they were coded in the opposite direction from the items with negative attitudes. Using these new values, a sum for the responses on item 14 was calculated. For each survey in which item 14 was correctly answered, this sum ranged from 0 to 104, creating a new variable called SUM. A sum of 0 would represent a student who strongly agreed with all the negative items and strongly disagreed with all the positive items. Thus this student would have an anxiety towards math. On the other hand, a sum of 104 would represent a student who strongly agreed with all the positive items and strongly disagreed with all the negative items, indicating no math anxiety. If a student was neutral on all 26 items, the sum would be 52. Thus, in general, a smaller sum would indicate a student with math anxiety, while a larger sum would indicate a student without math anxiety. The interval from 0 to 104 was then divided

Table 4-6
Contingency Table for Testing the
Independence of SUM with ANXIETY

Count / Row Percentages / Column Percentages / Total Percentages		ANXIETY Yes	ANXIETY No	Row Total
SUM	0-5	3 100.0 1.6 .8		3 .8
	6-12	7 87.5 3.8 1.8	1 12.5 .5 .3	8 2.1
	13-18	9 100.0 4.8 2.3		9 2.3
	19-25	17 51.5 9.1 4.4	16 48.5 7.8 4.1	33 8.5
	26-31	26 81.3 14.0 6.7	6 18.8 2.9 1.5	32 8.2
	32-38	32 71.1 17.2 8.2	13 28.9 6.4 3.3	45 11.5
	39-44	24 63.2 12.9 6.2	14 36.8 6.9 3.6	38 9.7
	45-51	18 33.3 9.7 4.6	36 66.7 17.6 9.2	54 13.8

continued on next page

Table 4-6 continued

	ANXIETY		
	Yes	No	Row Total
52-58	12 27.9 6.5 3.1	31 72.1 15.2 7.9	43 11.0
59-65	7 24.4 5.4 2.6	31 75.6 15.2 7.9	41 10.5
66-71	7 24.1 3.8 1.8	22 75.9 10.8 5.6	29 7.4
72-78	9 36.0 4.8 2.3	16 64.0 7.8 4.1	25 6.4
79-84	5 62.5 2.7 1.3	3 37.5 1.5 .8	8 2.1
85-91	4 33.3 2.2 1.0	8 66.7 3.9 2.1	12 3.1
92-97	3 42.9 1.6 .8	4 57.1 2.0 1.0	7 1.8
98-104		3 100.0 1.5 .8	3 .8
Column Total	186 47.7	204 52.3	390 100.0

into the following 16 categories: 0-5; 6-12; 13-18; 19-25; 26-31; 32-38; 39-44; 45-51; 52-58; 59-65; 66-71; 72-78; 79-84; 85-91; 92-97; and 98-104. Table 4-6 shows the contingency table for testing the independence of SUM with ANXIETY. A chi-squared value of 78.86759 with 15 degrees of freedom and p=.0000 (this actually indicates p<.0001) was calculated. This is significant. The Cramer's V was calculated and found to be .44969. In analyzing Table 4-6, it should be noted that students having a sum from 0 to 44 indicated that they had math anxiety more frequently than the students with a sum from 45 to 104. Thus, there is a medium relationship between the sums found for item 14 and math anxiety.

Pearson Product-Moment Correlation

The Pearson Product-Moment Correlation (denoted by r) is a coefficient which describes the relationship between two linearly related variables. This value gives two pieces of information about the relationship- its strength and its direction. Values of r range from -1 to 1, with the stronger relationships being given by values closer to -1 and 1. If r is positive, this indicates that smaller values of one variable are paired with smaller values of the second variable, while larger values of the first variable are paired with larger values of the second variable. A negative relationship indicates that larger values of the first variable are

paired with smaller values of the second variable, while smaller values of the first variable are paired with larger values of the second variable. To calculate r, the following formula is used:

$$r = \frac{\sum_{i=1}^{n} X_i Y_i - \frac{\sum_{i=1}^{n} X_i \sum_{i=1}^{n} Y_i}{n}}{\sqrt{\left[\sum_{i=1}^{n} X_i^2 - \frac{(\sum_{i=1}^{n} X_i)^2}{n}\right]\left[\sum_{i=1}^{n} Y_i^2 - \frac{(\sum_{i=1}^{n} Y_i)^2}{n}\right]}}$$

where n is the size of the population, X_i is the score for the first variable of the i^{th} member of the population, and Y_i is the score for the second variable of the i^{th} member of the population. Usually r is reported with a value for n and a significance level (p). Again, this value of p needs to be less than the set alpha-level (.05) in order for the test to be significant. As an aid in interpreting the r-value, it is normal to find the value of two other statistics- the coefficient of determination and the coefficient of nondetermination. The coefficient of determination is simply r^2, and represents the amount of variance shared by the two variables. The coefficient of nondetermination, denoted k^2, is calculated using the formula: $k^2=1-r^2$. This represents the amount of variance which is not shared by the two variables.

As was stated earlier, the Pearson Product-Moment Correlation Coefficient will be determined to test hypotheses 10-12. For those tests where r is significant, r^2 and k^2 will also be computed.

Hypothesis number ten states that there is no correlation between the student's high school GPA and math anxiety. For this hypothesis, an r-value of .0056 with n=472 and p=.452 was calculated. Since .452>.05, this is not significant. Thus the null hypothesis should be retained.

The eleventh hypothesis was that there is no correlation between the student's college GPA and math anxiety. An r-value of -.0386 with n=259 and p=.268 was calculated. Again, this r-value is not significant, and the null hypothesis should be retained.

The final hypothesis to be tested using the Pearson Product-Moment Correlation is hypothesis number twelve. This states that there is no correlation between the student's grade in the math class and math anxiety. The test for this hypothesis was conducted in two manners. First of all, r was calculated to determine the relationship between GRADE and ANXIETY without reference to the individual courses. Here, the r-value was .0178 with n=492 and p=.347. The second method used was to calculate an r-value testing the relationship between GRADE and ANXIETY for each course. For Intermediate

Algebra, an r-value of .1146 with n=99 and p=.129 was calculated. An r-value of -.0636 with n=156 and p=.215 was calculated for College Algebra. Math, It's Form and Impact had an r-value of .1209 with n=102 and p=.113. In General Calculus and Linear Algebra, an r-value of-.0996 with n=65 and p=.215 was computed. Finally, for Topics in Mathematics for the Elementary School Teacher, an r-value of -.1822 with n=72 and p=.063 was calculated. In any case, none of the r-values are significant. Hence, the null hypothesis should be retained.

Popular Causes of Math Anxiety

Using the responses to Item 17 on the survey, the popular causes of math anxiety as stated by the students can be determined. Of the seven categories formed for Item 17 in Chapter Three, very few students felt that categories 1, 2, 5, and 6 caused their math anxieties. Categories 3, 4, and 7 were listed as the major causes of math anxiety. Of the students with math anxiety, 64 students felt that at least part of their anxieties were caused by not being able to understand the concepts in mathematics. There were 40 students with math anxiety who felt that a bad experience in a math class had led to at least part of their math anxieties. Finally, 80 students with math anxiety listed a miscellaneous response as causing part of their math anxieties. See

Chapter Three (pages 26-28) for common responses placed in these three categories.

CHAPTER FIVE

CONCLUSION

Findings

The main purpose of this project was to examine the attitudes towards math of some of the students enrolled in a few of the lower-level math classes at Kansas State. By administering a survey to these students, information was gathered and fed into a computer. The null hypotheses listed in Chapter One were then tested. While not all of the hypotheses were significant, the following results were obtained.

A significant chi-squared value of 14.09829 was found to support the fact that there is a relationship between the type of math class being taken and math anxiety. It was discovered that students enrolled in Intermediate Algebra and College Algebra felt less math anxiety than students enrolled in Math,, It's Form and Impact and Topics in Mathematics for the Elementary School Teacher. The students in General Calculus and Linear Algebra were approximately equal as to who did and did not have math anxiety. Note Topics in Mathematics for the Elementary School Teacher being included in the group with the most math anxiety could cause some problems with some elementary school children at a later date. When they are taught by a teacher with math anxiety, this anxiety could be forced onto the child.

This study also revealed that there is a relationship between the number of high school math classes taken by the student and math anxiety. The significant chi-squared value was 18.58563. Those students who had taken one to two high school math classes were found to have more math anxiety than the students who had taken three to six high school math classes.

A third result revealed that there is a relationship between sex and math anxiety. A significant chi-squared value of 9.61753 was recorded. The data gathered from this test indicated that females tend to exhibit more math anxiety than males. This reinforces what other researchers have been saying for years.

As a note to future researchers in the field of math anxiety, some of the null hypotheses that were retained do warrant further investigation. The following null hypotheses should not be disregarded completely:

1. There is no relationship between race and math anxiety;

2. There is no relationship between the colleges in which the students are enrolled and math anxiety;

3. There is no relationship between the size of the high schools attended by the surveyed students and math anxiety; and

4. There is no relationship between parental attitudes and student attitudes.

There are two modifications to the procedure being used here, which a future researcher might want to consider. The first modification would be to expand the survey to include a time factor. A question concerning the number of years since the students last math course, and how they viewed their success in this class could lead to some interesting results. The second modification would be to conduct the surveys over a longer time period. Instead of confining the surveys to just the fall semester, some different results might be obtained if surveys were conducted in the spring and summer semesters also.

Recommendations

One recommendation which might alleviate some of the math anxieties found at the University level would be for more Universities to set up math anxiety clinics. Recall from Chapter 2 the work being done by Dr. Stanley Kogelman and Dr. Joseph Warren, as well as Sheila Tobias and Bonnie Donady. If more Universities had a place where students could talk of their anxieties towards math, they might be able to overcome them, or at least diminish them enough to make it through the required math course.

A second recommendation concerns the elementary education majors. Since previous research, as well as some of the information gathered in this project, indicates that elementary school teachers transmit their math anxieties to the students, some emphasis needs to be placed here. Using the math methods classes, as well as the Topics in Mathematics for the Elementary School Teachers class, inform these prospective teachers that they have an influence on their students. Maybe each prospective elementary teacher should be forced to research the topic of math anxiety. If they realize that they have math anxiety, they might be able to adapt some style of teaching math which hides their anxieties towards math. For those people who are already elementary school teachers (or even high school teachers), workshops or inservice days could be formed to deal with the topic of math anxiety.

As for sex differences in mathematics, some possible solutions do exist. In Chapter 2, it was discovered that some sex differences occurred because of the differences in play activities of youngsters. While it might be an impossible task to reach all parents, elementary school teachers could be made aware of the play activities of children, and try to influence the girls to play some of the same games as the boys. They

could emphasize those activities which help to develop the spatial abilities of their students.

School counselors also need to be made aware of the sex differences in mathematics. Some of their comments to students have created math anxiety in females. Counselors could be invited to attend workshops on math anxiety.

A final recommendation deals with the area of math avoidance. Several students indicated that their anxieties stemmed from a lack of exposure to math. High school students need to be informed of the benefits of taking more math in high school. High school counselors and teachers need to push students in the direction of taking more math. For those high school students planning to attend college, they need to be informed that most majors require at least College Algebra, and some require even a higher math class. Without the proper background in high school, a student may be faced with changing his/her major in order to avoid math in college.

In summary, the major recommendation is to make people aware of the problem of math anxiety. If teachers and counselors are kept informed, then maybe they will pass this information on to the student and hopefully eliminate some of the math anxieties.

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APPENDIX A

The following four pages are a duplication of the survey which was given to the students in selected lower level math classes at Kansas State University.

The following survey is being given to some of the students enrolled in math classes at K-State. In general, the survey will give us information concerning student's attitudes towards mathematics, and math anxiety. Your appreciation in answering the following questions as honestly as possible will be greatly appreciated.

I understand that my responses will be kept in strictest confidence and known only to myself and to the surveyor, Joleen Whitfill.
I give my permission to use the following information to gather statistics on math anxiety.

Signature_____

SURVEY ON MATHEMATICS ANXIETY

1.) ID #:_____

2.) Title of Class:_____Reference #:_____

3.) Year in College:_____ Freshman
_____ Sophomore
_____ Junior
_____ Senior
_____ Graduate

4.) Age:_____ below 25
_____ 25--35
_____ above 35

5.) Sex:_____ Male
_____ Female

6.) Race:_____ White
_____ Hispanic
_____ Black
_____ Asian or Pacific Islander
_____ American Indian or Alaskan Native
_____ Other (please specify)_____

7.) (Tentative) Major:_____

8.) (Approximate) High School GPA:_____

9.) (Approximate) College GPA (if you are a first semester freshman, do not answer):_____

10.) Class Rank in High School:_____ Top 1/3
_____ Middle 1/3
_____ Lower 1/3

11.) Size of High School:_____ less than 500
_____ 500-1000
_____ 1000-1500
_____ 1500 and up
OR: school district in which you graduated (number and state/country please):_____

12.) Please check which of the following high school math classes you have taken. Also state the grade which you received in the class.

General Math	_____	Grade	_____	
Business Math	_____	Grade	_____	
Algebra I	_____	Grade	_____	
Geometry	_____	Grade	_____	
Algebra II	_____	Grade	_____	
Advanced Math	_____	Grade	_____	
Other	_____	Grade	_____	(please specify) _____
Other	_____	Grade	_____	_____

13.) Do you become anxious when you hear the word mathematics?
_____yes _____no

14.) Read each of the following statements carefully and decide how you feel about it. Then indicate your feeling by circling the appropriate response according to:

A -- if you strongly agree
B -- if you agree
C -- if your feeling is neutral
D -- if you disagree
E -- if you strongly disagree

a.) Mathematics often makes me feel angry.	A	B	C	D	E
b.) I usually feel happy when doing mathematics problems.	A	B	C	D	E
c.) I think my mind works well when doing mathematics problems.	A	B	C	D	E
d.) When I can't figure out a problem, I feel as though I am lost in a mass of words and numbers and can't find my way out.	A	B	C	D	E
e.) I avoid mathematics because I am not very good with numbers.	A	B	C	D	E
f.) Mathematics is an interesting subject.	A	B	C	D	E
g.) My mind goes blank and I am unable to think clearly when working mathematics problems.	A	B	C	D	E
h.) I feel sure of myself when doing mathematics.	A	B	C	D	E
i.) I sometimes feel like running away from my mathematics problems.	A	B	C	D	E
j.) When I hear the word mathematics, I have a feeling of dislike.	A	B	C	D	E
k.) I am afraid of mathematics.	A	B	C	D	E
l.) Mathematics is fun.	A	B	C	D	E
m.) I like anything with numbers in it.	A	B	C	D	E
n.) Mathematics problems often scare me.	A	B	C	D	E
o.) I usually feel calm when doing mathematics problems.	A	B	C	D	E
p.) I feel good towards mathematics.	A	B	C	D	E
q.) Mathematics tests always seem difficult.	A	B	C	D	E
r.) I think about mathematics problems outside of class and like to work them out.	A	B	C	D	E
s.) Trying to work mathematics problems makes me nervous.	A	B	C	D	E
t.) I have always liked mathematics.	A	B	C	D	E
u.) I would rather do anything else than do mathematics.	A	B	C	D	E
v.) Mathematics is easy for me.	A	B	C	D	E
w.) I dread mathematics.	A	B	C	D	E
x.) I feel especially capable when doing mathematics problems.	A	B	C	D	E
y.) Mathematics class makes me look for ways of using mathematics to solve problems.	A	B	C	D	E
z.) Time drags in a mathematics class.	A	B	C	D	E

15.) Read each of the following statements carefully and decide which of the following statements best describes your mother's attitude towards mathematics. Circle the most appropriate letter.

a.) She loves mathematics
b.) She likes mathematics, and feels it is important.
c.) She is neutral when it comes to mathematics.
d.) She dislikes mathematics.
e.) She hates mathematics.

16.) Read each of the following statements carefully and decide which of the following statements best describes your father's attitude towards mathematics. Circle the most appropriate letter.

a.) He loves mathematics
b.) He likes mathematics, and feels it is important.
c.) He is neutral when it comes to mathematics.
d.) He dislikes mathematics.
e.) He hates mathematics.

17.) If you feel you have math anxiety, what do you consider to be the major cause of it? (Some possible causes are: I had a teacher who disliked math, and discouraged me; My parents don't think it is important; I can't seem to understand the concepts, and this discourages me; I had a bad experience with a math class; Math is a male-dominated field and I'm a female; or Math is too exact and we must always get the right answer.)

APPENDIX B

The following is a list of the classes surveyed. It includes the time and the day (or days) of the week that each class met.

MATH 010 - Intermediate Algebra

Reference Number 13970 met on Monday and Wednesday at 9:30 a.m. for recitation.

Reference Number 14020 met on Tuesday and Thursday at 8:30 a.m. for recitation.

Reference Number 14140 met on Tuesday and Thursday at 12:30 p.m. for recitation.

Reference Number 14160 met on Tuesday and Thursday at 3:30 p.m. for recitation.

MATH 100 - College Algebra

Reference Number 14270 met on Monday at 7:30 a.m. for recitation.

Reference Number 14350 met on Monday at 12:30 p.m. for recitation.

Reference Number 14410 met on Monday at 4:30 p.m. for recitation.

Reference Number 14440 met on Friday at 8:30 a.m. for recitation.

Reference Number 14520 met on Friday at 3:30 p.m. for recitation.

MATH 110 - Math, Its Form and Impact

Reference Number 14580 met on Monday, Wednesday, and Friday at 11:30 a.m.

Reference Number 14590 met on Monday, Wednesday, and Friday at 12:30 p.m.

MATH 205 - General Calculus and Linear Algebra

Reference Number 14720 met on Monday, Tuesday, and Thursday at 8:30 a.m.

Reference Number 14800 met on Monday, Wednesday, and Friday at 2:30 p.m.

MATH 308 - Topics in Mathematics for the Elementary School Teacher

Reference Number 15300 met on Monday, Tuesday, Wednesday, and Friday at 9:30 a.m.

Reference Number 15310 met on Monday, Tuesday, Wednesday, and Friday at 1:30 p.m.

APPENDIX C

The following is the actual coding procedure used in coding the information gathered from the surveys.

Column(s)	Description (Variable Name)
1-3	Each survey was given a 3-digit identification number **(ID)**.
4	Math class in which student was enrolled- 0 = Intermediate Algebra 1 = College Algebra 2 = Math, It's Form and Impact 3 = General Calculus and Linear Algebra 4 = Topics in Mathematics for the Elementary School Teacher **(CLASS)**
5-6	Reference number in which student was enrolled- 00 = Reference # 13970 01 = Reference # 14020 02 = Reference # 14140 03 = Reference # 14160 04 = Reference # 14270 05 = Reference # 14350 06 = Reference # 14410 07 = Reference # 14440 08 = Reference # 14520 09 = Reference # 14580 10 = Reference # 14590 11 = Reference # 14720 12 = Reference # 14800 13 = Reference # 15300 14 = Reference # 15310 **(REF)**
7	Students year in college 0 = Freshman 1 = Sophomore 2 = Junior 3 = Senior 4 = Graduate **(YEAR)**
8	Age of student 0 = below 25 1 = from 25 to 35 2 = above 35 3 = not available **(AGE)**

9	Sex of student 0 = Male 1 = Female 2 = not available **(SEX)**
10	Race of student 0 = White 1 = Hispanic 2 = Black 3 = Asian or Pacific Islander 4 = American Indian or Alaskan Native 5 = not available **(RACE)**
11-12	Major of student 00 = General Agriculture 01 = Agricultural Economics 02 = Agricultural Education 03 = Agricultural Mechanization 04 = Animal Sciences and Industry 05 = Bakery Science and Management 06 = Feed Science and Management 07 = Horticultural Therapy 08 = Horticulture 09 = Milling Science and Management 10 = Park Resource Management 11 = Pre-Forestry 12 = Grain Science 13 = Environmental Design 14 = Architecture 15 = Interior Architecture 16 = Landscape Architecture 17 = Arts and Sciences - General 18 = Anthropology 19 = Art 20 = Biology - General 21 = Computer Science 22 = Economics 23 = Fisheries and Wildlife Biology 24 = Geography 25 = Pre-Medical Records 26 = Pre-Nursing 27 = Pre-Occupational Therapy 28 = Pre-Pharmacy 29 = Pre-Physical Therapy 30 = Pre-Veterinary Medicine 31 = History 32 = Journalism and Mass Communications

33 = Leisure Studies
34 = Microbiology
35 = Modern Languages
36 = Music Education
37 = Music
38 = Physical Education
39 = Political Science
40 = Pre-Dentistry
41 = Pre-Law
42 = Pre-Medicine
43 = Psychology
44 = Radio-Television
45 = Social Sciences
46 = Sociology
47 = Social Work
48 = Speech
49 = Speech Pathology and Audiology
50 = Theatre
51 = Business Administration (undeclared)
52 = Business Pre-Professional
53 = Accounting
54 = Finance
55 = Management
56 = Marketing
57 = Education
58 = Elementary Education
59 = Secondary Education - Art
60 = Secondary Education - Business
61 = Secondary Education - English
62 = Secondary Education - History
63 = Engineering (undeclared)
64 = Architectural Engineering
65 = Construction Science
66 = Chemical Engineering
67 = Civil Engineering
68 = Electrical Engineering
69 = Computer Engineering
70 = Engineering Technology
71 = Industrial Engineering
72 = Mechanical Engineering
73 = Nuclear Engineering
74 = Apparel and Textile Marketing
75 = Apparel Design
76 = Consumer Affairs
77 = Early Childhood Education
78 = Life Span Human Development
79 = Foods and Nutrition Science
80 = Food Science and Industry
81 = Hotel and Restaurant Management
82 = Interior Design
83 = Nutritional and Exercise Science
84 = Undecided

85 = Blank
(MAJOR)

13-16 High school of GPA of student

9999 = not available
(HSGPA)

17-20 College GPA of student

9999 = not available
8888 = First semester freshman
(CGPA)

21 Student's rank in high school

0 = Top 1/3
1 = Middle 1/3
2 = Lower 1/3
3 = not available
(RANK)

22 Size of high school student attended

0 = less than 500
1 = from 500 to 1000
2 = from 1000 to 1500
3 = greater than 1500
(SIZE)

23 Indicates whether the student took General Math in high school

0 = taken
1 = not taken
2 = not available
(GMATH)

24 Grade of student in General Math

0 = A
1 = B
2 = C
3 = D
4 = F
5 = not available
6 = not necessary
7 = dropped
(GGRADE)

25 Indicates whether the student took Business Math in high school - same coding as column 23
(BMATH)

26 Grade of student in Business Math - same coding as column 24
(BGRADE)

27 Indicates whether the student took Algebra I in high school - same coding as column 23
(ALGI)

28 Grade of student in Algebra I - same coding as column 24
(AIGRADE)

29 Indicates whether the student took Geometry in high school - same coding as column 23
(GEOMETRY)

30 Grade of student in Geometry - same coding as column 24
(GEOGRADE)

31 Indicates whether the student took Algebra II in high school - same coding as column 23
(ALGII)

32 Grade of student in Algebra II - same coding as column 24
(AIIGRADE)

33 Indicates whether the student took Advanced Math in high school - same coding as column 23
(AMATH)

34 Grade of student in Advanced Math - same coding as column 24
(AGRADE)

35 Indicates whether the student took another math class in high school other than the one's previously listed - same coding as column 23
(OTHERI)

36	Grade of student in OTHERI - same coding as column 24 **(OIGRADE)**
37	Indicates whether the student took a second math class in high school not previously listed - same coding as column 23 **(OTHERII)**
38	Grade of student in OTHERII - same coding as column 24 **(OIIGRADE)**
39	Indicates the student's response to Item 13 0 = yes 1 = no 2 = sometimes **(ANXIETY)**
40-65	Indicates the student's responses to Items 14a to 14z 0 = A 1 = B 2 = C 3 = D 4 = E 5 = not available **(A14 to Z14)**
66	Indicates the student's response to Item 15 (attitude of mother) 0 = a 1 = b 2 = c 3 = d 4 = e 5 = not available **(MOM)**
67	Indicates the student's response to Item 16 (attitude of father) - same coding as column 66 **(DAD)**

68 Indicates if the student felt their math anxieties were caused by a teacher who disliked math

0 = applies
1 = doesn't apply
(A17)

69 Indicates if the student felt their math anxieties were caused by their parent's attitudes

0 = applies
1 = doesn't apply
(B17)

70 Indicates if the student felt their math anxieties were caused by a difficulty in understanding the concepts

0 = applies
1 = doesn't apply
(C17)

71 Indicates if the student felt their math anxieties were caused by a bad experience with a math class

0 = applies
1 = doesn't apply
(D17)

72 Indicates if the student felt their math anxieties were caused by the myth that math is a male-dominated field

0 = applies
1 = doesn't apply
(E17)

73 Indicates if the student felt their math anxieties were caused because math is too exact and we must get the right answer

0 = applies
1 = doesn't apply
(F17)

74 Indicates if the student felt their math anxieties were caused by some reason that hasn't been stated yet

0 = applies
1 = doesn't apply
(G17)

75 Grade of student in math course

0 = A
1 = B
2 = C
3 = D
4 = F
5 = Dropped
6 = Withdrew
7 = Incomplete
8 = Dropped by teacher
9 = No grade
(GRADE)

76 College in which the student is enrolled

0 = Agriculture
1 = Architecture
2 = Arts and Sciences
3 = Business
4 = Education
5 = Engineering
6 = Home Economics
7 = Undecided or Blank
(COLLEGE)

77 Number of high school math courses the student took

0 = not available
(YEARMATH)

APPENDIX D

The following is the actual coding for the surveys administered to the students. Every two lines represents one survey.

Reference Number 13970

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AN INVESTIGATION OF MATH ANXIETY AT KANSAS STATE UNIVERSITY

By

Joleen Marie Whitfill

B.A., Bethany College, 1980

AN ABSTRACT OF A THESIS OR REPORT

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Mathematics

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1988

ABSTRACT

This report examines the attitudes and anxieties of some of the students enrolled in lower-level math classes at Kansas State University. Information was gathered by surveying students in several of the math classes being offered during the Fall of 1987. This information was then used to test several hypotheses dealing with what are some of the major causes of math anxiety.

Using a chi-squared test for independence, tests were performed to see if there were any relationships between:

1. race and math anxiety;
2. colleges in which students are enrolled and math anxiety;
3. frequently recorded majors and math anxiety;
4. type of math class and math anxiety;
5. size of high school and math anxiety;
6. number of high school math courses taken and math anxiety;
7. sex and math anxiety;
8. parental attitudes and student attitudes; and
9. high school class rank and math anxiety.

The above tests revealed the following information:

1. Students enrolled in Math, It's Form and Impact and Topics in Mathematics for the Elementary School Teacher exhibited more math anxiety than students enrolled in Intermediate Algebra and College Algebra;

2. Students who took one or two high school math courses exhibited more math anxiety than those students who had taken three to six high school level math courses; and

3. Females exhibited more math anxiety than males.

The rest of the tests were insignificant.

Pearson Product-Moment Correlation Coefficients were calculated to test if there were any correlations between:

1. student's high school GPA and math anxiety;

2. student's college GPA and math anxiety; and

3. student's grade in the math class and math anxiety.

No significant results were found for these.