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ABSTRACT

The purpose of this study was to determine if teaching techniques and teacher attitudes tend to reduce math anxiety in secondary-level students. The research group consisted of 48 secondary students enrolled in Algebra I at a rural school in West Virginia, with the experimental period lasting 12 weeks. The control group was instructed in the teacher's usual manner, whereas the experimental group received treatment on coping with math anxiety. Treatment involved positive teacher attitudes, as well as cooperative learning and hands-on group activities. Math anxiety levels were measured using the Math Anxiety Rating Scale (MARS). Math anxiety levels were determined before and after the treatment and compared statistically using the t-test. Academic grades were also compared periodically. The MARS pretest and posttest comparison indicated that both the control and experimental groups began and ended the study with the same level of math anxiety. Likewise, both the experimental and control groups started the study on the same basic algebra skill level, progressed at nearly the same rate, and performed on the same level at the end of the study. Contains 48 references. (Author/PVD)

THE EFFECTS OF TEACHING TECHNIQUES AND TEACHER ATTITUDES ON MATH ANXIETY IN SECONDARY LEVEL STUDENTS

A Thesis

Presented to

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by

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This thesis submitted by Pamela Joy White has been approved meeting the research requirements for the Master of Arts Degree.

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ABSTRACT

THE EFFECTS OF TEACHING TECHNIQUES AND TEACHER ATTITUDES ON MATH ANXIETY IN SECONDARY LEVEL STUDENTS

Pamela Joy White

The purpose of this research project is to determine if teaching techniques and teacher attitudes tend to reduce math anxiety in secondary level students. The research was obtained from forty-eight secondary students enrolled in Algebra I at a rural school in West Virginia. The study was conducted over a twelve week period.

The control group was instructed in the teacher's usual manner while the experimental group received treatment on coping with math anxiety. The treatment involved positive teacher attitudes, as well as cooperative learning and hands on group activities. Math anxiety levels were measured by use of the Math Anxiety Rating Scale (MARS). Math anxiety levels were determined before and after the treatment and then were compared statistically using the t-test. Academic grades were also compared periodically as the study period progressed.

The statistical comparisons indicated no significant differences in levels of math anxiety or academic achievement after having received the treatment. The MARS pretest and posttest comparison indicated that both the control and experimental groups began and ended the study with the same level of math anxiety. Likewise, comparisons indicated that both the experimental and control groups started the study on the same basic algebra skill level, progressed at nearly the same rate, and performed on the same level at the end of the study.

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CHAPTER ONE

Introduction

Mathophobia as stated by Crypton is the fear of numbers - big ones, little ones, negative ones, fractions, percents and exponents. It is breaking into a cold, clammy sweat at the mention of the consumer price index or at the thought of figuring out the tip in a restaurant (5:121).

Math anxiety is indeed a fear of mathematics and numbers and has a great effect on the lives of many. In this ever changing society, Thompson with the Associated Press reported, life has become a jumble of numbers. The use of PIN numbers, the explosion of cellular phones, fax machines, and computers increases the need for memorizing and using numbers almost constantly (24:1). Everyone suffers from some level of math anxiety, although the range of levels is vast. Even competent mathematics professors experience some level of anxiety. Hackworth reminds us that math anxiety is not limited to unsuccessful people. Doctors, lawyers, teachers and business executives admit to math anxiety even though they have survived the educational system and vocations which impose some mathematical requirements. He mentions an accountant who does not balance his own personal checking account but relies solely on the bank statement and a chairperson of a mathematics department who never teaches word problems because she can not figure them out (46:5). Tobias states, "One of the truths about math anxiety that the disabled in math never seem to learn is that math anxiety can never be eliminated. The point is to manage it, as those who work in the field of mathematics learn to do" (25:40-41).

The level of this anxiety may be influenced by numerous factors, including age, sex, mathematical achievement and ability, and parental and teacher attitudes. This study

will, however, be concerned only with the influence of teaching techniques in the classroom and teacher attitudes.

The Research Questions

1. Did teaching techniques and teacher attitudes reduce math anxiety in secondary level students?

2. How did teaching techniques affect the level of math anxiety of the students in this study?

3. What influence did teacher attitudes have on the math anxiety level of the students in this study?

The Hypotheses

1. The null hypothesis is that teaching techniques will make no significant difference in the level of math anxiety of the students in the study.

2. The alternative hypothesis is that teacher attitudes will have no significant influence on the level of math anxiety of the students in the study.

The Delimitations

There is no intent in this study to rate the instruction of the teacher or to rate the school. The student population was limited to 48 students from selected sections of Algebra I, (grade levels ranging from 9-12) at Ritchie County High School, Ellenboro, West Virginia. This study did not attempt to determine the effect of any factors other than teaching techniques or teaching attitudes on math anxiety levels. The time frame began in August 1996 and continued for approximately twelve weeks through November 1996. Math anxiety levels were measured by the Math Anxiety Rating Scale (MARS). Student

academic progress was monitored according to the grades received in Algebra I.

The Assumptions

The first assumption. The first assumption is that the Mathematics Anxiety Rating Scale will accurately measure the level of math anxiety of each student.

The second assumption. The second assumption is that all secondary age students suffer from some level of math anxiety.

The third assumption. The third assumption is that a sample of 48 students is adequate in size and reflects a sample typical of secondary students.

The fourth assumption. The fourth assumption is that a time frame of twelve weeks is adequate for the study.

The Definitions of Terms

Math Anxiety. Math anxiety, according to Tobias, is a fear of mathematics or an intense, negative emotional reaction to mathematics (25:39).

Mathophobia. Mathophobia, as described by Crypton, is another name used for math anxiety (5:121).

Spatial Visualization. Spatial visualization is referred to by Sherard as the ability to visualize shapes and mentally move or rotate them (21:108).

The Importance of the Study

Math anxiety affects not only the self esteem of students but also choices in academic and career pursuits. Increased numbers of students are limiting considerably their career choices as well as their lives by suffering from math anxiety. While some help

is being given, on the college as well as secondary and elementary levels, much is yet to be accomplished. Only research will yield the solutions.

CHAPTER TWO

The Review of the Related Literature

An Overview

Math anxiety may affect students in any number of ways. While some students experience a fear of mathematics and totally avoid any unnecessary dealings with numbers or mathematical terms others have actual physical symptoms of trembling, perspiring, and nausea when forced to deal with mathematical situations as reported by Calvert's studies (33:9).

Math avoidance, Tobias notes, is not a decision made at a certain age, but rather is a continuing issue. Some students avoid math to avoid the anxiety; however, this does not always work as often basic skills are lost along with self-confidence and the student experiences anxiety again (possibly even at a higher level) when he/she is faced with mathematical situations (27:64-65).

Several studies including Calvert's have revealed that females have significantly higher levels of math anxiety than males, and that students who have taken higher level math courses and those receiving a grade of "C" or higher have lower levels of math anxiety than those students who have completed only general math courses and those who received lower grades (33:1).

Although some level of math anxiety is present in everyone, it seems that some are able to deal with the emotional fear and frustration more readily than others. As Smith concluded in her report on math anxiety, "certainly one difference between the math anxious and the math able lies in this reaction to frustration" (43:4).

The Anxiety

A college student becomes ill outside the math tutor's door before a help session; a successful attorney has to carry a "cheat" card to help him calculate a 15 percent tip; a woman still dreams she is being chased by numbers years after graduating; people refuse to balance checkbooks; parents break into a sweat when their children need help on algebra assignments. These are all common math anxiety experiences, as described by Gibson (13:38).

Math anxiety is learned; the fear is not innate. In fact, according to Tankersley, the fear of math is learned usually somewhere around fourth grade. In the early years, children are taught mathematical concepts by associating them with concrete objects or examples and later by symbolic representation. Then, somewhere around fourth grade, the teacher leaves the world of concrete and introduces the abstract. This appears to be where the problems begin (23:12).

If the life experiences of a math anxious person were studied, the circumstances under which the math anxiety was learned would be discovered. Math anxiety is learned and there is always some significant other person in the learning situation. Hackworth states that these teachers of math anxiety fall into the two categories: villains or loved ones. A third grader learned to be anxious when forced to sit under her desk when she could not repeat her multiplication facts quickly enough. The teacher, the significant person in this case, would be classified as a villain. In another situation a first year algebra student asked for help from her father. When he became quickly exasperated at her questions she was devastated. The lessons continued to get worse. The significant person here of course was the father, a loved one (46:34-35).

In attempting to understand exactly how math anxiety and the brain work, Tobias instructs one to think of the brain as a three part system, a memory bank, an input area and an understanding/recall pathway connecting the two. Under normal circumstances one

would look at mathematical information and call up the correct formula or information from the memory bank to proceed working. However, if one suffers from math anxiety, emotions come into play, panic develops and the understanding/recall pathway becomes cluttered by emotions creating a type of static in the brain. This in turn prevents the brain from functioning properly (48:6-7).

Anxiety is generally described in a dictionary as being uneasy or worried about what may happen; however, people who fear math will say uneasy or worried is too mild of a description of their feelings. When faced with mathematical tasks many people experience extreme discomfort. According to Pierce sixty to eighty percent of the population suffer to some degree. Some common reactions to math anxiety were listed as tension, blanking out, panic, paranoia, guilt, physical reactions (headaches, nauseous, cramps, blurred vision, sleepiness) and of course, avoidance (39:34).

Any physical reaction to math anxiety interferes with one's ability to correctly perform mathematics. As the anxiety increases so do the physical symptoms, thus decreasing the individual's math performance. Hackworth suggests using a process call Benson's Relaxation Response. This is a relaxing technique that reduces the negative physical reactions (46:76).

One of the first steps in gaining control over the anxiety, according to Pierce, is to reflect back on one's math history and try to pin point the specific class, experience or teacher that made him/her lose confidence in his/her math ability. This can be done individually or it is often helpful to talk with others to realize one is not alone in feeling anxiety. Once the negative experiences have been identified they can be replaced by positive thoughts and help can be sought (39:35).

Gibson refers to Arem and Tobias' research to give some tips on conquering math anxiety, which include keeping calm, stopping any negative self talk, visualizing oneself succeeding with math problems and breaking difficult math assignments up in to smaller parts (13:40).

The Female Role in Relation to Math Anxiety

"As a rule, girls have a harder time with math than boys, but primarily because society tells them that's the way it should be" states Fiske (11:65).

The studies showing the levels of math anxiety and contributing factors in females are quite broad and somewhat controversial. According to Fiske's studies, girls tend to do better in math than boys through elementary school then they begin to slip at the junior high level. Here girls are being conditioned by society that only boys pursue fields of engineering, science, etc. (11:66). According to Human Behavior's "Math Misery" the problem stems from the fact that from the ninth grade on girls tend to avoid math because of societal pressures. By the time they are ready for college their mathematical background is too weak to meet requirements for the entry level science and math courses (17:67)

Bernstein reported that during a research project in New Jersey gender was found to be a significant factor as related to math anxiety between fourteen and nineteen years of age. Prior to age fourteen males and females expressed no significant difference in math anxiety levels. The importance of females having reinforcing math experiences and understanding the importance of math in their lives was also expressed (30:5).

Fiske also referred to Tobias' argument that socialization regarding math begins well before the early teenage years. Girls play "store" or Monopoly and get practice in basic mathematical calculations while boys may follow their favorite baseball player's batting average and gain insight into concepts of ratios and percentages (11:66). Tobias suggests all the skills necessary for understanding mathematics may not be learned at school. Children who miss out on the experiences of measuring, computing and manipulating objects while playing may not be as well prepared for math in school. Girls probably do not learn much about gravity, distance and shapes and sizes by playing with dolls. While boys are usually taking things apart and putting them back together, building

something, or possibly learning a lesson on speed and distance from playing baseball or football (26:65).

Reilly's research indicates that female and male students' anxiety levels appear to be similar at the junior high age but as they enter higher levels of math in high school females begin to exhibit higher levels of math anxiety. It has been suggested that society does not expect the female student to be good at math so she may choose not to exert sufficient effort to overcome fears and enroll in higher level math classes. This of course severely limits career options of females (40:16). Reilly also refers to Flessati and Jamieson's research which indicates that females report higher levels of math anxiety because society accepts their admitting to the weakness in math more readily than males. Males may actually underreport their feelings of math anxiety because of cultural expectations (40:5).

Donady and Tobias cited mathematician John Ernest's conclusion in his phamplet "Mathematics and Sex" that boys may not like math any better than girls but they are made aware that it will be necessary for the kinds of careers they intend to pursue (8:50). However, Iker reported in his article "A Math Answer for Women" that more girls are presently signing up for advanced math classes because they plan to pursue careers other than being homemakers (15:45). Parents need to be informed of the importance of a full mathematics education for their daughters as well as for their sons Fauth and Jacobs conclude in "Equity in Mathematics Education" (10:490).

In contrast to the aforementioned studies in a national survey of 1,452 thirteen year olds and 1,788 high school seniors, Hollifield found no large differences in mathematics participation. This study was significant because previous studies have found such differences that it is given as a primary reason for males dominating the field (14:26). Likewise in her study of "Sex Differences in Achievement Related Affect" Meece found although there was some tendency for females to feel slightly more math anxiety it was not terribly significant (37:1).

Fiske again referred to what John Ernest, professor of mathematics at the University of California, identifies as the "Pygmalian effect" according to which students perform in accordance with teacher expectations. In a survey of a group of teachers he found that almost half of the teachers expect their male students to do better in mathematics while none of them expect the female students to do better (11:67).

According to Becker's dissertation "A Study of Differential Treatment of Females and Males in Mathematics Classes" it was found that males tend to receive more encouragement and that females were in fact in some instances discouraged in their academic endeavors. It was concluded that classroom and informal interaction were both predominately with the male students (2:142-43). Likewise Gutbezahl reported from her work on "Female's Math Confidence" that teachers expect less academically from girls and treat them differently from boys. Boys are also attended to more, receive more help than girls from teachers, and are called on more often to give answers in class (35:7-8).

Although this research study does not deal with the differences in anxiety levels for males and females, information involving teacher attitudes and expectations relate to this study.

Methods of Dealing with Math Anxiety on the Post-Secondary Level

Mathematics clinics or workshops are the major route for reaching post-secondary students and providing them with assistance in coping with their math anxiety. Time magazine reported that after much study on why math is avoided especially by women when it is so vital in almost every field of endeavor, Shelia Tobias of Wesleyan University headed a math clinic in 1975 initiating a program in psychological counseling for math students. The program involved finding the students' confidence levels and beginning work from there. Several approaches are used, some review high school math, others attend workshops, and others present math in game form so that the theory can be learned (18:36).

A concept, as studied by Dellens, which appears in all definitions of math anxiety is that math anxious people are unable to work math problems to the extent of their ability because of their emotional reaction to mathematics. This reaction must be dealt with if the individual is to reduce his math anxiety level (34:3).

Dew and Galassi's study on the college level demonstrated that math and test anxiety are related but not identical and a modest relation between anxiety and math performance can be identified. They suggest that interventions designed to do more than reduce anxiety are needed to produce maximal improvements in math performance. Remedial math skill interventions that are presented in low anxiety settings seem to be in order (6:582-3). Likewise, Siegel, Galassi and Ware concluded that if researchers and practitioners want to increase math performance on the college level, the first area of concentration should be an intervention to increase skills. These interventions should in turn be expected to increase performance and efficacy expectations and, as a by-product, reduce math anxiety (22:537).

Lazarus describes another program being initiated as math anxiety reduction for students preparing to be elementary teachers. "If the teacher is tense and ill at ease with mathematics, such feelings infect the class with the idea that mathematics is hard or unpleasant." The program was designed to improve problem solving skills, reduce math anxiety and increase confidence in mathematics (16 :8). Tittle's research points out that teacher attitudes and anxiety affect students so it is important especially for elementary teachers to have positive attitudes about mathematics (45:1). Math anxiety has its roots in the early years of schooling. Fauth notes that it is here that it is important to develop positive attitudes toward the study of mathematics and understand its usefulness and importance (10:489).

Colleges can provide training sessions for future teachers and counselors to minimize math anxiety. Bernstein recommends that these might include having math instructors conduct self assessment of gender and ethnicity disparities in the classroom as

related to response opportunities, feedback, etc., offering women considering entrance into nontraditional careers, a stress free math refresher course, inservice workshop on nontraditional assessment and counseling skills, and teaching the visualization technique called "anchoring", that increases relaxation and reduces anxiety when thinking about math (30:6).

Math clinics are places where adults can bring special problems about learning math and get help with them. During these group sessions the members discuss their mental blocks about math and find that they are not alone. Pierce's work shows a math anxiety bill of rights (see appendix A, page 46) that has been developed to help restore self-confidence (39:37). After some self-confidence has been restored, the teacher introduces small bits of mathematics relevant to the student's level of understanding. Tobias conceded that "feelings about mathematics appear to get in the way of learning unless the feelings are identified and treated." At the clinics counselors help the individual remember their negative feelings about mathematics and when they began (25:39-40).

A quote from Barnes describes an all too common occurrence. "She recalled a feeling of defeat in fourth grade arithmetic when the teacher didn't seem to care whether she learned her multiplication tables. But it didn't matter because she wanted to be an actress and math was not important." As a result all through school she took only the math she needed to graduate, Later when mathematics was required in college (even though she was going to be an actress) she panicked (1:6).

For most people who suffer from high levels of math anxiety, Tobias explains, the first thing they remember about failing at math is that it felt like a sudden death. The incident may have occurred with word problems in the sixth grade, an equation in high school or with calculus or statistics in college. Regardless of when or where the feeling came, it came suddenly and in a very frightening way. The new idea was not only difficult but it was impossible! Instead of seeking help most people have the feeling that they will never go any further in mathematics (26:63). Tobias continues that at some point in their

math career they failed to some degree to understand what was being explained. Despite the fact that they may have been quite capable up to this point, they have reached the end of their capabilities and continue by "faking" math for years without complete understanding. This sudden death produces feelings of guilt and shame along with helplessness and results in true math anxiety (25:39).

Methods of Dealing with Math Anxiety on the Secondary and Elementary Levels

Individuals can sometimes cope with math almost by instinct in day to day living but when they are asked to sit down and compute a similar math problem they panic. Fiske's work relates such an incident.

> One night recently a coed at Wesleyan University went out to the local pizza parlor with six friends. At the end of the meal, when the waiter arrived with a check that looked like the formula for nuclear fission, she was the only one at the table who could figure out how much each person owed including the tip. The following morning the same student was confronted with a routine algebra problem in math class. She froze and could not handle it (11:64).

According to Fiske, this is a classical case of math anxiety. People can perform math related work in a day to day situation that they are so used to doing that they forget it involves math. For example some women panic at balancing their bank accounts when they compare prices and do mental calculations every day at the grocery store (11:64).

Many people have emotional barriers which prevent them from pursuing the study of math. Negative experiences somewhere, whether at elementary, junior high or high school discourage further math encounters. Pierce notes that many otherwise confident and capable people feel they just do not have a "math mind" and will never be able to understand math. Yet studies show there is no such thing as a "math mind" and almost everyone is capable of doing math once his/her attitude about math has changed. Failure

to do well in math has much more to do with attitude and lack of study skills than it does with lack of ability (39:31).

Brush's work indicates that although both counselors and teachers can play a vital role in helping students overcome high levels of math anxiety it would seem that teachers "need to convince students that mathematics can be enjoyable (a change in many students' present attitudes) and increase their participation in mathematics endeavors" (32:36).

Meece, Wigfield and Eccles' study confirms that value perceptions play a critical role in determining students' intentions to enroll in advanced math classes. Teachers can help enhance students' valuing of math. Some enhancing methods would be explicitly relating the value of math to students' everyday lives, making math personally meaningful, and counseling students about the importance of mathematics and career choices. This study reported that in 400 hours of classroom observation fewer than a dozen instances of these behaviors were observed. Greater attention definitely needs to be given to this aspect of mathematics education (19:69).

Research conducted by Reilly has yielded some interesting ideas. Age was found to be a significant factor relating to math anxiety. The twelve year olds were the most anxious, with the fourteen to seventeen year old group having the lowest levels of math anxiety. Students generally became less anxious as they progressed in grade level. The grade the student received in the most recently completed math course was directly related to the level of math anxiety. As academic grades improved confidence levels were increased. Taking math courses also appeared to be important in reducing math anxiety. Students who had completed college prep math and algebra classes were more confident than those who had not taken the courses (40:11-15).

As was pointed out previously when discussing females and teacher expectations and as Sherard's "Math Anxiety in the Classroom" explains, teachers should avoid sex role stereotyping in the math classroom. Teachers should not differ in their interaction with

males and females or in performance expectations. Positive models or achievers from both sexes should be pointed out (21:106).

Teachers should strive to make the students aware of everyday usefulness of mathematics. "The key to preventing mathophobia is letting mathematics take root in the student's daily life. Reality based teaching will go a long way toward solving the national mathematics problem because it will put elementary mathematics into a form that will make sense to children," reported Lazarus (16:10). Students should be encouraged to take more math classes. The teacher should point out the importance and use of math in everyday life regardless of sex or career choices.

Wigfield and Meece conducted research on worry as associated with math anxiety. Among the conclusions arrived at was the suggestion that students who do poorly in math but attach little importance to math may not be anxious. However, students who do poorly but want to do well may report higher levels of math anxiety (28:214).

Sherard's studies reveal that the instructor can help students develop self-confidence in their ability to do mathematics. It should be stressed again that everyone can do mathematics once the emotional blocks are removed. Work ought to begin on a level at which everyone understands and has some confidence. On this level each student should attain some success before the progression begins. Students should be encouraged to trust their first impression as many students erase their first answer and replace it with an incorrect one (21:107)

Dodd writes in her "Insights from a Math Phobic" that math phobics can be created by teachers placing too much emphasis on memorizing and not taking individual student approaches to learning into consideration. She suggests giving students a questionnaire about math feelings the first day of class. This allows the teacher to work on changing negative feelings even though it is a slow process. Wise use of games and group activities can restore lost confidence. Another possible solution is collaborative and cooperative learning activities. Working in groups or pairs may be the solution to

overcoming the loneliness part of the anxiety. Often, pairing advanced students with those whose skills are less developed is a good idea. Sometimes extending the support to telephone buddies for homework questions is another possibility. Dodd also mentions considering how long students can sit without moving or talking. For teenagers usually thirty minutes is a long time, so activities during a class period should be varied (7:296-7).

Sherard says emphasis should be placed on problem solving, spatial skills and the language and symbolism of mathematics. Some feel that word problems are at the heart of math anxiety. Teachers can help students develop methods of solving these word problems and give them the much needed practice on problem solving by solving one or two problems in class each day regardless of material being covered that particular day. Spatial skills are usually difficult for students to develop. The teacher can help here by relating the use of spatial skills in everyday life, such as objects moving in space in sports. The mathematical language and symbolism must be explained carefully (21:108). One suggestion by Smith was to read problems only one phrase at a time and translate it to math language and symbols for easier understanding. The mathematical language can be difficult, especially the verbal ambiguities. For instance, in fractional multiplication the actual operation involves division of the smaller denominator into the larger numerator and in addition of positive and negative numbers the actual computation involves subtraction. The teacher must be very explicit and patient in explaining these ambiguities (42:7).

The instructor should refrain from teaching behaviors that are inflexible or excessively authoritarian. Some feel that math is not creative. One is not generally asked to give his/her opinion and the answer is either right or wrong with no in between. Sherard suggests that interaction among students should be encouraged when responding to questions so as not to place the teacher in such an authoritative position. He also points out that it is helpful to give the student partial credit if part of the work is correct

and that students should be taught ways to estimate and approximate answers (21:109). Barnes notes that getting an answer to a problem and knowing how it was derived are independent processes, one involves intuition, the other involves logic (1:7). Thus, according to Fiske, teachers should give credit on a series of logical steps to a solution rather than strictly a right or wrong answer (11:66-67). Clopton writes in "Tips for Beginners" that when students ask for assistance in working problems his response is to ask the student to explain what they do know and how they got to that point. This helps the teacher focus on what the problem is and builds confidence in the student by allowing him/her to demonstrate what he/she knows. Many times the student solves the problem or sees the area of difficulty as he/she talks through the problem without teacher intervention (4:30).

Teachers are sometimes guilty of stressing one best way to solve a problem and requiring all students to use that method. Barnes warns that this approach limits the student's creativity. Perhaps students should be presented the problem and allowed to discover new challenging ways to solve it on their own (1:7).

It is important that the teacher be aware of the possible negative effects of the process of testing on math anxiety. A definite relationship between tests and math anxiety exists. Reilly's research shows a strong relationship between test anxiety and math anxiety. Students who were anxious about math tests were also anxious about other tests. Those most confident in math were carefree about non math tests as well (40:16). Sherard suggests that teachers can ease the pressure by not over emphasizing testing but using other criteria for grading as well, such as classwork, projects and homework. The amount of stress and anxiety should not be increased by timing the test. Students should be able to relax and take the test without being rushed. Retesting should be allowed when necessary (21:109). Smith further suggests giving unsigned quizzes where the students do not sign their names but the teacher can quickly determine the level of comprehension.

Also, having students rate test questions on an anxiety scale of 1-10 can be helpful (42:11-12).

Leffingwell reports from his "Reduction of Test Anxiety in Students Enrolled in Mathematics Courses: Practical Solutions for Counselors" that teachers should provide study guides and break materials down into easy steps so that students can adequately prepare for tests. He also indicates that a test should progress in difficulty so the student can experience success early in the test. Realistic goals of achievement should be pointed out to the student, grades should be based on a number or criteria instead of tests exclusively, and alternate tests and times should be available for less stressful situations (36:6-8).

Sherard points out that teachers should abstain from insensitive behaviors in the teaching situation. Teachers must be supportive and encouraging. Every effort should be made to avoid making snide remarks, assigning math for punishment or making extremely long or difficult assignments. A student should never be humiliated by being asked to go to the blackboard to do a problem he/she obviously cannot do (21:110). It is also often helpful for students to work in a committee or group as they would in a social studies class, suggests Fiske (11:67). Another interesting activity, relayed by Smith, is to appoint a "dummy-of-the-week" each week whose duty is to ask any question anyone else feels is too stupid to ask. The question is written down and passed to the "dummy" who in turn asks the teacher (42:11-12).

A relaxed, supportive classroom atmosphere should be provided for the student. The teacher should be patient and be sure his/her attitude toward math is positive because it will be reflected in the teaching, reminds Sherard (21:110). Meyer in her study of "Attitudes of Elementary Teachers Toward Mathematics" found the teacher to have the most effect on the students' attitude toward mathematics. Of 61 students with positive feelings toward math, of several choices given, 30 indicated their teachers have the most

influence on their attitudes. Of 59 students with negative feelings toward math 37 indicated their teachers have been the major influence (38:3).

Teague set up a methods class for elementary teachers and found that when attitudes toward math changed or improved so did their teaching ability. In accordance with his research he cited evidence that the teacher's attitude toward mathematics is significantly related to the student's attitude and achievement in mathematics (44:2). Bohuslov's report on dealing with math anxiety refers to both the studies of Aiken and the research of Cooper and Petrosky that both found evidence of significant influence of the instructor in the student's attitudes about mathematics (31:9).

Several studies have been conducted to determine if parental attitudes or teacher attitudes have a stronger influence on the student. The results are somewhat controversial. For example, Austin-Martin found the teacher's attitude to be the most influential (29:5-7) while Echols found the parental influence to be the more significant in her research (9:47-52).

Many students believe the subject of mathematics is boring, difficult, unneeded and threatening to the ego. Blum-Anderson suggests these beliefs can be altered into more positive ones if teachers take time to develop mathematical affect along with the development of mathematical cognition. Her research provides ten strategies to include affect in mathematics classrooms. These include helping students understand frustration, the importance of positive teacher vocabulary, cooperative learning , decreasing individual achievement, making connections between mathematics and occupational uses and using advertising campaigns for mathematics courses (3:433-435).

Gibson's article on "Learning What Counts" includes tips to help parents incorporate math into the day-to-day lives of their children (13:40). Preschoolers could use car trips to understand time, distance, and identify shapes. Bath time allows for

measuring and comparing volumes. Children ages five to eight should use card games to develop memory skills and pattern recognition as well as learning to estimate and compare heights, weights, size, etc. Those children nine to twelve years should be included on family shopping trips to compare prices and discounts, perhaps do scale drawings of a room to determine furniture arrangements and develop bar graphs of monthly electric bills. Teenagers should be involved in major purchases (like a new car), encouraged to establish bank accounts and budgets and perhaps keep records and graphs of miles driven and gasoline used in family vehicles. Parents who deal in positive ways with math situations and allow math to be fun will have a great positive influence on how their children view math.

Summary

As Sherard's research concludes

> Many educators are now recognizing math anxiety as a hindrance to learning mathematics. Math anxiety can be described a fear of mathematics or an intense, negative emotional reaction to mathematics. Its effects on people are quite varied. Some people may have such acute anxiety about mathematics that they avoid mathematics at any cost with the ultimate effect of handicapping themselves both in their everyday lives and in their employment opportunities (21:106).

Math anxiety seems to be ever present, and must be dealt with in an effective manner. Research seems to indicate that this solution is clinics and workshops with teachers and counselors on the post-secondary level and modification of teacher attitudes and teaching techniques for the elementary and secondary levels. As Dodd put it, teachers who limit their teaching to traditional methods will continue to create math phobics, while those who expand their repertoire of teaching strategies will likely see an increase in the number of math fans. The first goal of every teacher should be to help students believe they can learn (7:298).

CHAPTER THREE

Methods and Procedures

Sources of Data

The data for this research were obtained from selected sections of Algebra I (grade levels 9-12) at Ritchie County High School, Ellenboro, West Virginia. The study was conducted over a period of twelve weeks.

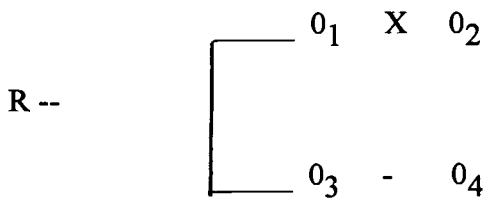
Ritchie County High School is a rural high school with grades nine through twelve, with approximately six hundred to six hundred fifty students attending the school. Most of the students come from low and middle income families.

The research involved forty-eight students, twenty-five of whom acted as a control group and received no treatment. The classes were randomly selected as to which acted as control groups and which were experimental groups. The same instructor taught all groups so as to eliminate any extra variables. No explanation was made to the students concerning the research study or testing; however, administrators were familiarized with the research study.

At the onset of the research study, both the control and experimental groups were tested to determine the level of math anxiety of the student. The Mathematics Anxiety Rating Scale (MARS) designed by Richardson and Suinn (20:138-149) was administered as the test of anxiety level. After the testing was completed the teacher instructed the students designated as the control group in the usual manner. The remaining students, henceforth referred to as the experimental group, received a treatment on coping with math anxiety. The treatment involved positive teacher attitudes and modified teaching techniques. At the end of the twelve weeks all students were again given the MARS test to determine any change in math anxiety levels.

Research Methodology

The experimental method of research methodology was used for this study. Using the categorization designed by Campbell and Stanley, the experimental study was of the general classification of true experimental design. More specifically, it is of the pretest-posttest control group design. The experimental group and the control group were randomly selected. The experimental group was evaluated, subjected to the experimental variable, and reevaluated. The control group was evaluated at the beginning and end of the study. The paradigm for the pretest-posttest control group design is:



The bracketing shows that R, the random selecting process, is common to both groups. X is the experimental variable. 0_1 and 0_2 are the evaluations of the experimental group. 0_3 and 0_4 are the evaluations of the control group. The - indicates that the control group is isolated from the experimental variable, as described by Leedy (47:168-170).

Treatment of the Data

The data for this study were taken from the comparison of the pretest and posttest levels of math anxiety. Then a comparison study of any significant change in levels of math anxiety between the control and experimental groups was performed. This comparison for significant difference was performed statistically by the use of the t-test.

The teacher kept accurate records of teaching techniques employed as the treatment for the experimental group. These included (1) positive teacher attitude toward student ability and achievement; (2) avoiding sex role stereotyping in the classroom and

keeping records of students being called on in class to ensure equalization; (3) making students aware of the everyday usefulness of mathematics; (4) helping students to develop self-confidence by using cooperative learning activities; (5) concentrating on problem solving skills, language and symbolism; (6) avoiding inflexible teaching behaviors and the authoritarian position; (7) being aware of the possible negative effects of the testing process; and (8) providing a relaxed, supportive classroom atmosphere by incorporating games, hands on activities and group work.

The Mathematics Anxiety Rating Scale (MARS) designed by Richardson and Suinn (1972) was used to determine the level of math anxiety of the students in the pretest and posttest situations. (See appendix B, page 47, for sample of questions). This ninety-eight question test according to research seems to be the most valid and most widely used scale in measuring the level of math anxiety. According to Fulkerson, J. Galassi, and M. Galassi the MARS is designed to assess math anxiety in a wide variety of ordinary life and academic situations and has the greatest amount of psychometric, reliability, and validity data (12:378). The validity was attested to in Rounds' and Hendel's "Measurement and Dimensionality of Mathematics Anxiety" (20:138-149) and in their "Factor Structure of the Mathematics Anxiety Rating Scale" (41:1-34). Results of both the pretest and posttest were recorded for statistical comparison.

Collecting Pretest Data

The sections were designated as either experimental or control groups before the initial meeting of the classes to eliminate any teacher prejudice. The experimental group consisted of twenty-three students while the control group had twenty-five students. Grade level and sex distribution were fairly consistent between the two groups, see Figures 1 and 2.

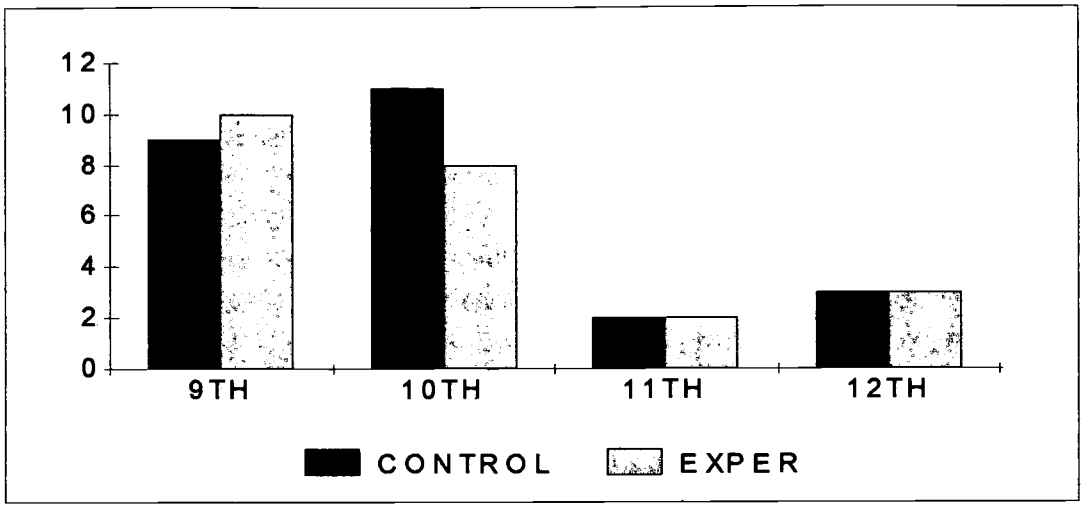


Figure 1

Grade Level Distribution

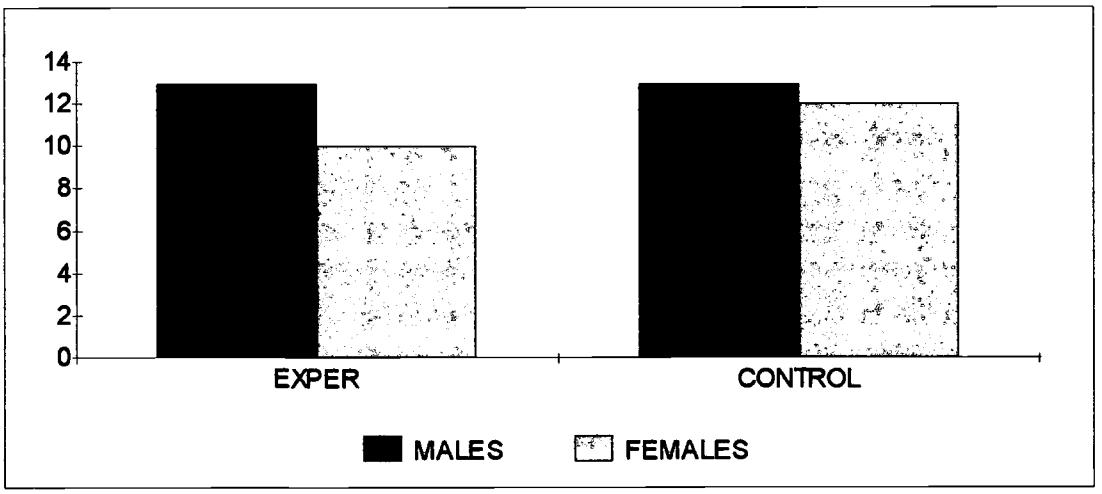


Figure 2

Sex Distribution

During the first session of class, the MARS (Math Anxiety Rating Scale) test was administered to both the experimental and control groups to determine the level of math anxiety in each group. During the second session of each class, a pretest was administered

to each group to test very basic mathematics skills. The results of both the MARS test and the mathematics pretest were recorded to use for later comparison.

Experimental Procedure

The control group. The control group received no special variable and was taught using the teacher's usual method. The one exception was that students were asked to keep a journal of their feelings about mathematics to be recorded on specified dates. Students were given an introduction and explanation for each section in the textbook, examples were reviewed, and assignments were made. After four or five sections were covered, students were tested. Six weeks grades were derived from a combination of homework assignments, worksheets, and tests.

The experimental group. The experimental group received several extra assignments outside of the usual textbook problems, were frequently allowed to work in groups or with partners, and were encouraged and positively reinforced by the teacher. The six weeks grades for this group were derived not only from homework assignments, worksheets, and tests but from individual and group projects. The inclusion of the projects into the six weeks grades decreased the importance of the test grades in figuring the six weeks grades. Grades are figured on a point system with tests being worth 100 points, homework and worksheets being worth five points, and projects ranging from 10 to 50 points depending upon the specific project. Students were also required to keep a journal to record how they felt about mathematics on certain specified dates.

The introduction of project type activities was used to spark interest in those individuals opposed to continual repetitive book work . Some projects were designed to be fun and others were to relate mathematics to the everyday world. As previously stated, some were individual projects while others were group projects with everyone in the group receiving the same grade (number of points) for the project. Questions about the projects were included on the tests to make sure all members of the group knew how to

complete all group work and calculations. This resulted in higher level students within the group helping the lower level students to understand all procedures.

The first project concerned surveys. Students were given survey papers and were asked to survey ten people outside of the classroom concerning how many and what type of pets they owned. This was an individual project. After bringing the information to class, survey results were complied using means, modes, medians, and dot frequency diagrams.

In another individual project, students kept records of television viewing for one week. Students were to keep records of the times they watched television and the total number of hours and minutes spent watching television. These records were again brought to class to be combined and compared. Classroom charts and dot frequency diagrams were constructed indicating the average number of hours of television watched nightly and weekly, as well as the hours during the day when television was most frequently watched.

An additional assignment involving television was to watch television for a designated hour and to record types of commercials during the hour. Pie charts were then designed to show the percentages and types of commercials during the viewing time.

One of the major group projects was a travel project. Students were divided into groups and each group member (because not all groups had an equal number of people) was given a specified amount of money. Students were then to combine their money and plan a group trip. Students could travel anywhere in the United States for seven days. Students were required to submit a budget including transportation, food , lodging, etc. Map reading was necessary as a description of exact routes and number of miles was required. Students were given a road atlas and several lodging booklets which included rates. One group member was required to give an oral description of the trip planned and basic information about location and cost. Each group was required to complete a travel graph showing distances and intervals of travel and to complete a pie chart indicating what

percent of their money was spent for food, transportation, lodging, etc. A variety of trips were planned including fishing expeditions, amusement parks, and beach vacations.

In addition a project was designed to integrate health into the algebra classroom. Students used literature from cigarette companies offering free merchandise for cigarette package labels to determine the cost of promotional jackets, T-shirts, etc. in terms of life expectancy. Multiplication was used to determine the cost of one's life after being given the number of minutes each cigarette takes from a human life. Students also wanted to figure the cost in dollars and cents of smoking. Smoking costs for a year, five years, etc. were figured and other ways of spending that money was discussed.

Other small projects included measuring items in the classroom, finding area of various rooms and hallways as well as converting recipes to serve different amounts. These involved the use of fractions, multiplication and division.

The last major project that the students completed was called "Get a Job." It involved researching different professions as to job outlook, salary, benefits, and educational requirements. Students then chose a profession they were interested in and wrote a one page paper about their research. The next step was to write a letter to an individual or a company related to the profession chosen. Included with the letter was a prepared survey that asked about types of math and math education necessary for each job. After the surveys were returned to the students and brought to class, the results were graphed on large bar graphs in the classroom. Also included as part of the survey was an example of a math problem used daily on the job. Students were then asked to copy these problems onto index cards and to share this problem as well as a brief description of the job with the class in an oral presentation.

Daily the teacher attempted to reflect a positive attitude concerning mathematics. Every effort was made to make the students feel comfortable in the mathematics classroom. Students were never required to work on the board unless they volunteered to do so. Cooperative learning, group work and partner work were incorporated much of

the time. Records were kept when calling on students for questions in class so as not to repeatedly call on the same students. Every attempt was made by the teacher to reduce math anxiety and create an enjoyable atmosphere while relating mathematics to everyday world situations.

Collecting Posttest Data

At the end of the twelve week experimental period both the control and the experimental groups were given the MARS test a second time. At this time both groups were also administered a posttest on basic algebra skills. This posttest was identical to the pretest given to both groups at the beginning of the twelve week period.

Treating the Data

After all tests were administered and scores were tabulated, these results were entered into the computer. A computer spreadsheet program was set up in Microsoft Works to run the calculations for a basic two sample t-test. The results from running the t-tests on the data were recorded and stored for comparison.

Pretests from both the control and experiment groups were compared statistically to determine if both groups were at the same level in basic algebra skills at the beginning of the study. Pretests and posttests were compared in both the control and experimental groups to determine achievement in basic algebra skills for each group. Posttests were again compared from both groups to determine if the average achievement in basic algebra skills remained the same between the groups.

Academic grades in Algebra I were compared statistically to determine any significant differences in achievement levels. Comparisons were made for each major test, as well as for the six weeks grading periods.

The results of the MARS test given to each group at the onset of the study were compared statically by the t-test to determine if the beginning math anxiety levels between

the groups were similar. The results of the MARS test given at the beginning were compared with the results of the MARS test given at the end of the study to determine if the anxiety levels changed due to the treatment administered. The final MARS test results were again compared between the experimental and control groups to determine if anxiety levels remained similar at the end of the study. Ten questions from the 98 question MARS test were also compared individually by the use of the t-test to determine where statistical differences might occur.

CHAPTER FOUR

Analysis of Data

Comparison of Pretest /Posttest Results

The t-tests compared data of the basic algebra skills pretests as well as posttests for both groups. Pretest and posttest results were also compared to one another for both the experimental and control groups. Results are recorded in Table 1.

Table 1

Algebra Basic Skills Pretest/Posttest Comparison

Comparison	A	B	$A - \overline{A}$	$B - \overline{B}$	t-test	critical t	Accept or Reject Ho
Pretest	Experiment	Control	5.435	5.24	0.2657	2.021	Accept
Posttest	Experiment	Control	7.13	7.28	-0.238	2.021	Accept
Experiment	Pretest	Posttest	5.435	7.13	-2.216	2.021	Reject
Control	Pretest	Posttest	5.24	7.28	-3.3875	2.021	Reject

As shown in the table above, the comparison of the pretests for the experimental and control groups supported the null hypothesis as no significant differences were indicated in the t-test. Likewise, on the posttest comparison of the two groups the null hypothesis was accepted. This indicated that both the experimental and control groups started the study on the same basic algebra skill level, progressed at nearly the same rate, and performed on the same level at the end of the study.

When the pretest for each individual group was compared to the posttest for that particular group the null hypothesis was rejected as statistically a significant difference was indicated by the t-tests. This difference is demonstrated in the following, Figure 3.

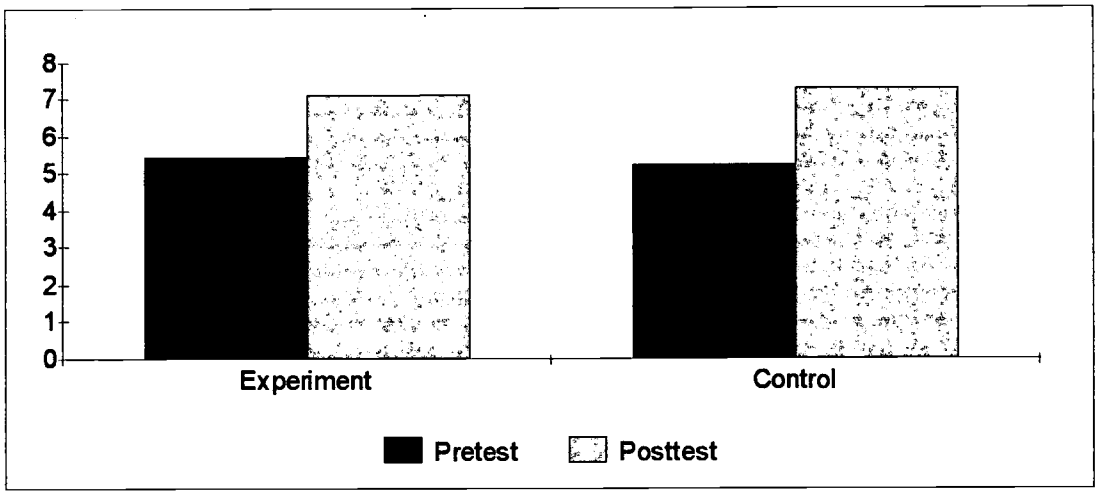


Figure 3

Algebra Basic Skills Pretest/Posttest Comparison

Figure 3 indicates that both the experimental and control groups improved in basic algebra skills from the pretest to the posttest.

Academic grades for the two groups were also compared for each major test as well as for each six weeks grading period. As indicated in Table 2 , no significant differences were evident between the groups in academic performance. (The t-tests showed Test 3 as the only point where there was any significant difference in academic performance between the experimental and control groups.)

Table 2

Academic Grade Comparison

Test or Grade	Experiment	Control	t-test	critical t	Accept or Reject Ho
Pretest	5.435	5.24	0.2657	2.021	Accept
Test 1	86.826	87.4	-0.2064	2.021	Accept
Test 2	85.217	88.92	-1.3918	2.021	Accept
Test 3	78.87	86.24	-2.5396	2.021	Reject
1st 6 Wks	87.565	90.08	-1.1574	2.021	Accept
Test 4	88.609	85.64	0.9872	2.021	Accept
Test 5	74.043	73.8	0.0467	2.021	Accept
Test 6	89.739	84.2	2.0188	2.021	Accept
2nd 6 Wks	83.13	79.56	1.0663	2.021	Accept
Posttest	7.13	7.28	-0.238	2.021	Accept

The academic similarities between the two groups are also shown in Figure 4.

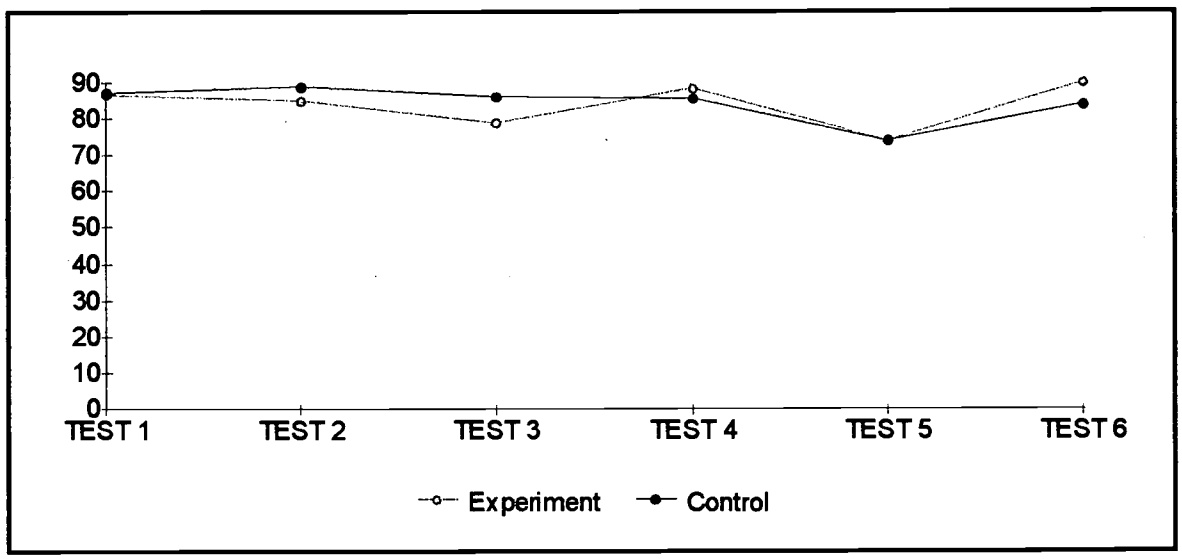


Figure 4

Academic Grade Comparison

Likewise, Figure 5 below compares the six weeks grading period averages for the experimental group and the control group.

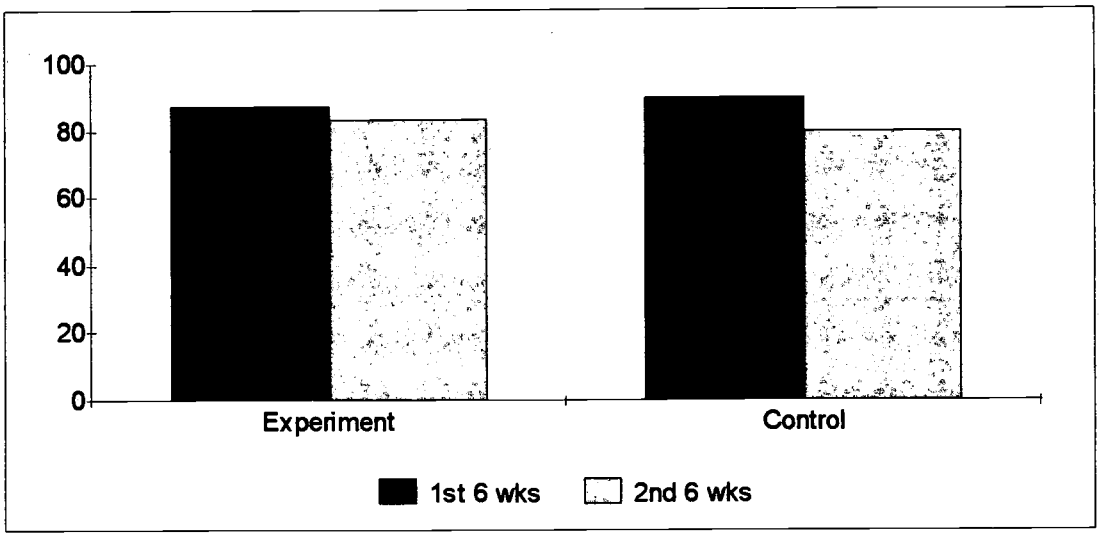


Figure 5

Six Weeks Grading Period Comparison

Math anxiety was measured with the MARS (Math Anxiety Rating Scale). Each group was given the MARS test at the beginning of the twelve week period and again at the end. Comparisons using the t-tests indicate that no significant differences were found between the anxiety levels of the two groups at the beginning or end of the treatment period, nor were there any significant differences between each individual group's beginning and ending math anxiety levels. These results are summarized on Table 3.

Table 3

Math Anxiety Rating Scale Comparison

Comparison	A	B	$A - \bar{A}$	$B - \bar{B}$	t-test	critical t	Accept or Reject Ho
Pretest	Experiment	Control	194.652	217.88	-1.1866	2.021	Accept
Posttest	Experiment	Control	198.739	223.04	-1.1467	2.021	Accept
Experiment	Pretest	Posttest	194.652	198.739	-0.1981	2.021	Accept
Control	Pretest	Posttest	217.88	223.04	-0.2563	2.021	Accept

The MARS comparisons are also demonstrated in the following, Figures 6 and 7.

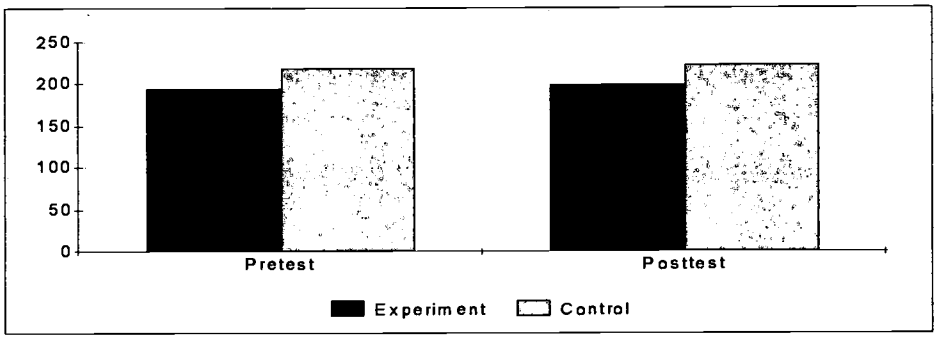


Figure 6

MARS Comparison

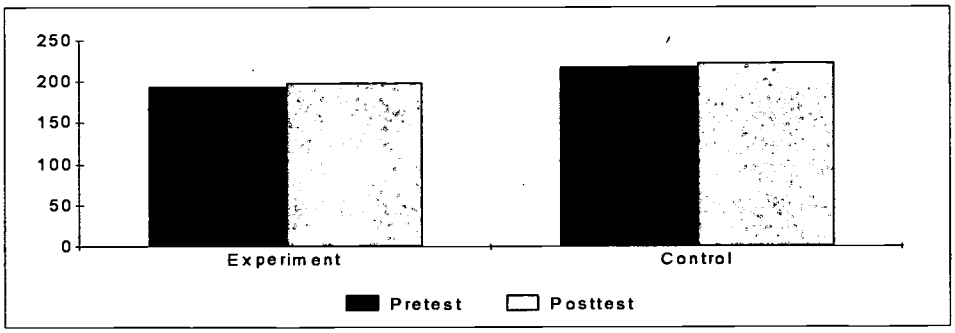


Figure 7

MARS Comparison for Each Group

Following is a breakdown of the MARS to specific questions as chosen by the teacher to be of interest to the study. Ten questions were chosen to be compared. This represents about ten percent of the 98 question test. The ten questions were chosen by the teacher as questions that related to or were relevant to Algebra and were distributed throughout the test. Each question on the test is actually a statement in which the student is asked to mark on a scale of one through five an indication of the amount of fear associated with that statement.

Questions studied for comparison included (3) having someone watch you as you divide a five digit number by a two digit number; (15) doing a word problem in algebra; (34) studying for a math test; (40) solving a square root problem; (45) raising your hand in a math class to ask a question; (54) taking an examination (final) in a math course; (61) having a friend try to teach you a math procedure and finding that you cannot understand what he/she is telling you; (72) being given a homework assignment of many difficult problems which is due the next class meeting; (76) thinking about an upcoming math test 5 minutes before; and (96) being asked to explain how you arrived at a particular solution for a problem.

A pretest comparison was done between the control and experimental groups' responses on the selected questions. The results, as shown in Table 4, indicate acceptance of the null hypothesis as no significant differences were shown.

A posttest comparison of the two groups also supported the null hypothesis as no significant differences were again indicated. These results are shown in Table 5.

The final comparison was done between each individual group's pretest and posttest. This was to determine if the anxiety level had changed any within the group after the treatment was administered. The comparisons for the experimental group indicated no significant differences between pretest and posttest results supporting the null hypothesis. These findings are recorded in Table 6. The comparisons for the control group, however,

did indicate a significant difference on only one question. This significant difference was shown on question 40. All other questions supported the null hypothesis and indicated no significant differences. These results are recorded in Table 7.

Table 4

Pretest Comparison of Selected MARS Questions

Question #	Exper. Avg.	Control Avg.	t-test	critical t	Accept or Reject Ho
3	2.609	2.64	-0.0836	2.021	Accept
15	2.217	2.96	-1.9882	2.021	Accept
34	2	2.64	-1.6615	2.021	Accept
40	2.696	3.16	-1.1877	2.021	Accept
45	1.87	2.28	-1.0534	2.021	Accept
54	2.87	3.08	-0.4428	2.021	Accept
61	2.13	2.48	-0.8338	2.021	Accept
72	2.478	2.6	-0.3123	2.021	Accept
76	2.826	3.12	-0.6052	2.021	Accept
96	2.304	2.68	-0.8473	2.021	Accept

Table 5

Posttest Comparison of Selected MARS Questions

Question #	Exper. Avg.	Control Avg.	t-test	critical t	Accept or Reject Ho
3	2.391	2.56	-0.4745	2.021	Accept
15	2.174	2.72	-1.4671	2.021	Accept
34	2.522	2.6	-0.1918	2.021	Accept
40	2.3348	2.28	0.1848	2.021	Accept
45	2	2.08	-0.2185	2.021	Accept
54	2.6696	2.48	0.5137	2.021	Accept
61	2.391	2.28	0.3304	2.021	Accept
72	2.522	2.36	0.4206	2.021	Accept
76	3.174	3.08	0.2171	2.021	Accept
96	2	2.56	-1.5475	2.021	Accept

Table 6

Experimental Group's Pretest/Posttest

Comparison of Selected Mars Questions

Question #	Pretest	Posttest	t-test	critical t	Accept or Reject Ho
3	2.609	2.391	0.5127	2.021	Accept
15	2.217	2.96	-1.09882	2.021	Accept
34	2	2.522	-1.2389	2.021	Accept
40	2.696	2.348	0.8243	2.021	Accept
45	1.87	2	-0.3352	2.021	Accept
54	2.87	2.696	0.364	2.021	Accept
61	2.13	2.391	-0.6557	2.021	Accept
72	2.478	2.522	-0.1083	2.021	Accept
76	2.826	3.174	-0.7009	2.021	Accept
96	2.304	2	0.7029	2.021	Accept

Table 7

Control Group's Pretest/Posttest

Comparison of Selected MARS Questions

Question #	Pretest	Posttest	t-test	critical t	Accept or Reject Ho
3	2.64	2.56	0.262	2.021	Accept
15	2.96	2.72	0.6414	2.021	Accept
34	2.64	2.6	0.1071	2.021	Accept
40	3.16	2.28	2.6063	2.021	Reject
45	2.28	2.08	0.5447	2.021	Accept
54	3.08	2.48	1.427	2.021	Accept
61	2.48	2.28	0.5502	2.021	Accept
72	2.6	2.36	0.6423	2.021	Accept
76	3.12	3.08	0.0941	2.021	Accept
96	2.68	2.56	0.3177	2.021	Accept

The Hypotheses

The null hypothesis was that teaching techniques would make no significant difference in the level of math anxiety of the students in the study. The alternate hypothesis was that teacher attitudes would have no significant influence on the level of math anxiety of the students in the study.

The data from the MARS was statistically evaluated using the t-test to determine if there were indeed any significant differences in the math anxiety level of the students in the study. Each t-test was set up to test: H_0: $A - B = 0$

$$H_1: A - B \neq 0$$

$$\alpha = .05$$

In all t-tests performed on data comparing the experimental group with the control group both in the pretest (before any experimental variable was introduced) and in the posttest (after the experimental variable was introduced) the null hypothesis was accepted, proving there was no significant difference in the level of math anxiety of the students in the study.

T-tests were also performed on data comparing the pretest to the posttest for the experimental group. In each case the null hypothesis was accepted, indicating there were no significant differences in math anxiety levels as a result of the experimental variable. Likewise, the t-tests were used to compare the pretest to the posttest for the control group. In most cases the null hypothesis was again accepted showing no significant difference in math anxiety levels. The only exception, which showed a rejection of the null hypothesis indicating a significance difference was on question 40. Here the control group's pretest average was 3.16 while the posttest average was 2.28, indicating that the anxiety level decreased on this particular question. The question concerned solving a square root problem.

Other Findings

The comparisons of the academic grades for the control and experimental groups indicated that the academic progress in the algebra classes was similar for the two groups during the twelve week period of study. The t-tests comparing the academic grades on major tests and for six weeks grading periods showed no significant differences between the two groups. There was one exception on Test 3, the average grade for the experimental group was 78.87% and the average grade for the control group was 86.24%, which resulted in the rejection of the null hypothesis, thus indicating a significant difference on that particular test.

The comparison of the basic algebra skills pretest and posttest for each individual group rejected the null hypothesis. This indicated that the skill level of each group in algebra changed significantly during the twelve week period. However, the comparison of the group's pretests and posttests with one another showed that change must be constant for the two groups. The t-test comparing the experimental group's pretest with the control group's pretest and the t-test comparing the experimental group's posttest with control group's posttest both supported the null hypothesis and showed no significant difference.

Summary of Results

The results of this study indicate that neither teaching techniques or teacher attitudes had any significant influence on the level of math anxiety of the students in this study. Furthermore, it appears that neither teaching techniques or teacher attitudes had any significant effect on academic grades of the students in this study.

CHAPTER FIVE

Summary, Conclusions, and Recommendations

Summary

The purpose of this study was to determine if modifying teaching techniques and teacher attitudes would affect the math anxiety level in secondary level students. An experimental group of 23 secondary students and a control group of 25 secondary students were used for the study's sample. Both groups were sections of Algebra I. The experimental variable was to change teaching techniques to include group, partner, cooperative learning, projects, and hands on activities. Teacher attitudes were also modified to reflect positive useful attitudes toward mathematics and attempt to reduce math uneasiness. The study continued for a twelve week period.

Math anxiety levels were determined by use of the MARS. The MARS was administered to both groups at the beginning of the twelve week period of study and again at the end of the study.

A basic algebra skills pretest and posttest was also administered to both groups. In addition to these instruments for statistical study, academic grades for major tests and six weeks grading periods were available for comparison. T-tests were used for statistical comparisons. Numerous t-tests were performed on the above mentioned data, comparing both the experimental and control groups to one another and comparing each individual group's pretests and posttests as to the changes occurring during the period of study. Almost every t-test performed supported the null hypothesis indicating that there were no significant differences in the two groups.

Conclusion

The statistical evaluations by t-tests of the MARS results supported one hundred percent the null hypothesis. This concludes that according to this study neither teaching techniques or teacher attitudes affected the math anxiety level of the secondary students.

It was also indicated by statistical comparisons that teaching techniques and teacher attitudes did not affect academic grades of the students in the study.

It is the researcher's opinion that teacher attitudes are difficult to modify and reflect differently to individual groups. In any research of this type, it should be taken into consideration that a teacher automatically tries to reduce math anxiety in all classes and with all groups. It is difficult, if not impossible, for a math teacher to not try to make all students comfortable with math and math concepts.

Recommendations

It is recommended that further study be completed in the area of reduction of math anxiety by using a larger sample and a longer period of study. As stated above, it seems teaching techniques should be concentrated on more than teacher attitudes. A broader range of teaching techniques and their effectiveness in reducing math anxiety needs to be researched. Sharing of successful teaching techniques among classroom teachers may be the vital key in reducing math anxiety.

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APPENDIX A

MATH ANXIETY BILL OF RIGHTS

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 for help.

I have the right to say I don't 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.

APPENDIX B

The following is a list of questions used on the Mathematics Anxiety Rating Scale (MARS). The questions refer to things and experiences that may cause fear or apprehension. The student is instructed to work quickly but to consider each item. Each item is to be marked to describe how much fear is associated with it. The choices for each item are: (1) Not At All, (2) A Little, (3) A Fair Amount, (4) Much, or (5) Very Much.

1. Determining the amount of change you should get back from a purchase involving several items.
2. Having someone watch you as you total up a column of figures.
3. Having someone watch you as you divide a five digit number by a two digit number.
4. Being ask to add up 976 + 777 in your head.
5. Dividing a five digit number by a two digit number in private with pencil and paper.
6. Calculating a simple percentage e.g., the sales tax on a purchase.
7. Listening to a salesman show you how you would save money by buying his higher priced product because it reduces long-term expenses.
8. Listening to a person explain how he figured out your share of expenses on a trip, including meals, transportation, housing, etc.
9. Having to figure out how much it will cost to buy a product on credit (figuring in the interest rates).
10. Totaling up a dinner bill that you think overcharged you.
11. Telling the cashier that you think the dinner bill was incorrect and watching the cashier total up the bill.

12. Being treasurer of a club.

13. Totaling up the dues received and the expenses of a club you belong to.

14. Adding up 976 + 777 on paper.

15. Doing a word problem in algebra.

16. Solving a problem such as: $11X = 11$ and $Y = 3$ then the results of X/Y is equal to _____?

17. Solving the problem such as $11X = 12$ and $Y = 4$ then the ratio of X to Y is equal to _____?

18. Determining the grade point average for your last term.

19. Reading an article on the basketball team, showing what percentage of free throws each player made, the percentage of field goals made, the total number attempted, etc.

20. Reading an historical novel with many dates in it.

21. Counting the number of pages left in a novel you are engrossed in.

22. Guessing at the number of people attending a dance you're at.

23. Buying a math textbook.

24. Watching someone work with a slide rule.

25. Watching a teacher work an algebraic equation.

26. Signing up for a math course.

27. Listening to another student explain a math formula.

28. Walking into a math class.

29. Having to compute the miles/gallon on your car.

30. Watching someone work with a calculator.

31. Looking through the pages of a math text.

32. Working on an income tax form.

33. Reading your W-2 form (or other statement showing your annual earning and taxes).

34. Studying for a math test.

35. Starting a new chapter in a math book.

36. Walking on campus and thinking about a math course.

37. Meeting your math teacher while walking on campus.

38. Reading the word "Statistics".

39. Sitting in a math class and waiting for the instructor to arrive.

40. Solving a square root problem.

41. Signing up for a course in statistics.

42. Checking over your monthly bank statement.

43. Taking the math section of a college entrance exam.

44. Having someone explain bank interest rates as you decide on a savings account.

45. Raising your hand in a math class to ask a question.

46. Reading and interpreting graphs or charts.

47. Reading a cash register receipt after you purchase.

48. Figuring the sales tax on a purchase that costs more than $1.00.

49. Having a person illustrate to you the best way to divide your money into a savings and a checking account.

50. Figuring out which summer job offer is the most lucrative: where one involves a lower salary, room and board, and travel, while the other one involves a higher salary but no other benefits.

51. Reading a formula in chemistry.

52. Hearing a lecture in social science class where the instructor is commenting on some figures, e.g., the percentage of each socio-economic group who voted Republican.

53. Taking an examination (quiz) in a math course.

54. Taking an examination (final) in a math course.

55. Hearing two of your friends exchanging opinions on the best way to calculate the cost of a product.

56. Having someone ask you to recheck his figures in a simple calculation, such as division or addition.

57. Being asked by a friend to answer the question: how long will it take to get to Denver if I drive at 30 miles per hour.

58. Studying for a driver's license test and memorizing the figures involved such as the distances it takes to stop a car going at different speeds.

59. Hearing friends make bets on a game as they quote the odds.

60. Playing cards where numbers are involved, e.g., bridge or poker.

61. Having a friend try to teach you a math procedure and finding that you cannot understand what he is telling you.

62. Scheduling my daily routine to allocate set times for classes, for study time, for meals, for recreation, etc.

63. Juggling class times around at registration to determine the best schedule.

64. Deciding which course to take in order to come out with the proper number of credit hours for full-time enrollment.

65. Working a concrete, everyday application of mathematics that has meaning to me, e.g., figuring out how much I can spend on recreational purposes after paying other bills.

66. Working on an abstract mathematical problem, such as: "if X = outstanding bills, and Y = total income, calculate how much you have left for recreational expenditures".

67. Being given a set of numerical problems involving addition to solve on paper.

68. Being given a set of subtraction problems to solve.

69. Being given a set of multiplication problems to solve.

70. Being given a set of division problems to solve.

71. Picking up a math textbook to begin working on a homework assignment.

72. Being given a homework assignment of many difficult problems which is due the next class meeting.

73. Thinking about an upcoming math test 1 week before.

74. Thinking about an upcoming math test 1 day before.

75. Thinking about an upcoming math test 1 hour before.

76. Thinking about an upcoming math test 5 minutes before.

77. Talking to someone in your class who does well about a problem and not being able to understand what he is explaining.

78. Waiting to get a math test returned in which you expected to do well.

79. Waiting to get a math test returned in which you expected to do poorly.

80. Walking to math class.

81. Realizing that you have to take a certain number of math classes to fulfill the requirements for graduation.

82. Realizing that you have to take a certain number of math classes to fulfill the requirements in your major.

83. Being called upon to recite in a math class when you are prepared.

84. Not knowing the formula needed to solve a particular problem.

85. Receiving your final math grade in the mail.

86. Opening a math or stat book and seeing a page full of problems.

87. Being responsible for collecting dues for an organization and keeping track of the amount.

88. Getting ready to study for a math test.

89. Listening to a lecture in a math class.

90. Figuring out your monthly budget.

91. Being given a "pop" quiz in a math class.

92. Seeing a computer printout.

93. Having to use the tables in the back of a math book.

94. Being told how to interpret probability statements.

95. Asking your math instructor to help you with a problem that you don't understand.

96. Being asked to explain how you arrived at a particular solution for a problem.

97. Tallying up the results of a survey or poll.

98. Acting as secretary, keeping track of the number of people signing up for an event.

APPENDIX C

MATH ANXIETY QUIZ

Please circle the number that most closely reflects your feeling in each of the following situations.

1. When the teacher says he/she is going to ask you some questions to find out how much you know about math, how much do you worry that you will do poorly?

Not At All						Very Much
1	2	3	4	5	6	7

2. When the teacher is showing the class how to do a problem, how much do you worry that other students might understand the problem better than you?

Not At All						Very Much
1	2	3	4	5	6	7

3. When I am in math, I usually feel

Not at all at ease and relaxed						Very much at ease and relaxed
1	2	3	4	5	6	7

4. When I am taking math tests, I usually feel

Not at all nervous and uneasy						Very nervous and uneasy
1	2	3	4	5	6	7

5. Taking math tests scares me.

I never feel this way						I very often feel this way
1	2	3	4	5	6	7

6. I dread having to do math.

I never feel this way						I very often feel this way
1	2	3	4	5	6	7

7. It scares me to think that I will be taking advanced high school math.

Not At All						Very Much
1	2	3	4	5	6	7

8. In general, how much do you worry about how well you are doing in school?

Not At All						Very Much
1	2	3	4	5	6	7

9. If you are absent from school and you miss a math assignment, how much do you worry that you will be behind the other students when you come back to school?

Not At All						Very Much
1	2	3	4	5	6	7

10. In general, how much do you worry about how well you are doing in math?

Not At All						Very Much
1	2	3	4	5	6	7

11. Compared to other subjects, how much do you worry about how well you are doing in math.

Much less than other subjects						Much more than other subjects
1	2	3	4	5	6	7

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