ATTITUDE OR ANXIETY:

MATHEMATICS DISPOSITION OF HIGH SCHOOL ALGEBRA I STUDENTS

A Thesis by

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I have examined the final copy of this Thesis for form and content and recommend that it be accepted in partial fulfillment of the requirement for the degree of Master of Education in Curriculum and Instruction.

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We have read this thesis and recommend its acceptance:

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DEDICATION

To my father, Raymond Clarke, who chose his family over completing his own thesis

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ABSTRACT

The purpose of this study was twofold: (a) to investigate the prevalence of mathematics anxiety among freshman Algebra I students in an urban, Midwestern high school, and (b) to find out if a pre-quiz and quiz intervention could reduce mathematics anxiety in one specific class. The Mathematics Anxiety Rating Scale for Adolescents (MARS-A) was the primary quantitative data collection instrument. Qualitative data were collected using the Mathematicsitude Survey, student reflections, and interviews. Findings from the MARS-A showed that 50% of students experienced a significant amount of mathematics anxiety, particularly associated with test-taking. However, there was a large amount of variation among scores. In the treatment class, a strategy of pre-quiz followed by the same or similar quiz the following day was used to build student confidence and thereby lessen anxiety. The strategy did not meet this objective as many students reported greater anxiety levels after the intervention than before. Qualitative probing did show that in some isolated cases the strategy worked very well.

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CHAPTER I

INTRODUCTION

Rationale

For the last three years, I observed high school students who appeared to enter their new mathematics classroom with fear and trepidation. Some of them tried to sit at the back unnoticed while others warned me that they had never before passed a mathematics course. I saw students who appeared to have negative attitudes and those who seemed apathetic. Some students attempted to avoid the class altogether. Despite the prevalence of students with negative or apathetic attitudes, several students were enthusiastic and eager to excel at a subject they enjoyed. I wondered what impact these varied attitudes might have on each student's performance in their mathematics class and suspected that the negative attitudes were connected to mathematics anxiety. Perhaps students were masking their anxiety with pessimism or apathy.

Students' attitudes toward mathematics can be an obstacle to their learning. This is supported in the related literature (Bolick & Alagic, 2001; Hembree, 1990; Sousa, 2001; Wigfield & Meece, 1988). A prior lack of success in a subject can lead to a student developing a lower self-concept and eventually avoidance of that subject (Sembera & Hovis, 1993; Sousa). Past failures in a particular area actually cause the brain to block incoming information pertaining to that topic (Sousa). It is not a wonder, therefore, that by the time students reach high school, those who have experienced failure in elementary or middle school mathematics actually shut down in Algebra I.

In order to help high school students with negative or fearful attitudes toward mathematics to be successful in Algebra I, the effects of their previous failures must be overcome. New positive experiences must be facilitated in such a way that the student's selfconfidence improves and the brain receives and integrates new information (Sousa, 2001). This mission is reflected in the 2000 National Council of Teachers of Mathematics (NCTM) standards, which state, “students' understanding of mathematics, their ability to use it to solve problems, and their confidence in, and disposition toward, mathematics are all shaped by the teaching they encounter in school. The improvement of mathematics education for all students requires effective mathematics teaching in all classrooms” (p. 16).

Purpose

The purpose of this study was to determine the prevalence of mathematics anxiety in Algebra I students at a Midwestern, urban high school and to implement a strategy to reduce anxiety in one class of students enrolled in the lowest level of Algebra I. Thus, the research was designed to investigate two questions: what is the mean level of anxiety among the Algebra I students being surveyed, and will students in the treatment class have reduced levels of anxiety after the treatment? The ultimate goal was to use a particular intervention to build student confidence in mathematics in order to overcome previous negative experiences and thereby positively affect students’ attitudes towards mathematics learning and test taking. The expectation was that students experiencing reduced mathematics anxiety would be more willing to learn and, therefore, would perform better than they had previously.

CHAPTER II

REVIEW OF THE LITERATURE

A review of the literature conveyed rising awareness of the impact of mathematics anxiety on students' attitudes toward mathematics, performance in mathematics, and choices regarding future learning, especially among college-age students (Hembree, 1990; Meece, Wigfield, & Eccles, 1990; Resnick, Viehe, & Segal, 1982). The focus of this study, however, was the prevalence of mathematics anxiety as well as the potential to reduce mathematics anxiety through use of a specific confidence-building strategy. Therefore, the following literature review focuses on mathematics anxiety, tests of mathematics anxiety, and strategies to reduce mathematics anxiety.

Mathematics Anxiety

In 1972, Richardson and Suinn defined mathematics anxiety as "feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations" (p. 551). According to Tobias (1993), this anxiety begins with a particular incident. She described that pivotal moment as feeling like "sudden death" (p. 50). For many people, this moment occurs sometime during their school career when they encounter a mathematics problem that seems impossible. The experience of failure becomes a block to furthering their study of mathematics (Tobias).

As Tobias (1993) worked with adults experiencing mathematics anxiety, she found commonalities in their stories. Some adults had given up on understanding mathematics when they were in elementary school, some when they were in high school and others when they were in college or even graduate school. Each individual reported that after the initial moment of anxiety, they continued to be afraid that people around them would discover their weakness

(Tobias). The fear paralyzed people and prevented them from seeking help. Thus, they were not able to overcome the obstacle to mathematics.

Tobias (1993) proposed several reasons that students, no matter how far along they are in their educational journey, are unable to move beyond their paranoia in mathematics. The first reason is that students focus on getting the right answer, and when they cannot reach it or get the wrong answer, they are too embarrassed or afraid to learn from their mistakes. This mindset is linked to the second reason that Tobias provided; there is a sense in American culture that mathematical success is based on ability, not on effort or perseverance. If a student believes they are not predestined to be good at mathematics, then they give up when they inevitably meet an insurmountable problem.

Resnick et al. (1982) studied mathematics anxiety in college students and found that students in lower level classes experienced more anxiety than students in higher-level classes. Does this mean that anxiety disappears with higher grade levels or that students with a high level of anxiety do not pursue higher-level mathematics classes? Is this true in high school mathematics as well? If so, then Algebra I students would experience high levels of mathematics anxiety, since they are in the lowest level of mathematics classes offered. Resnick et al. also confirmed a weak, but significant correlation between students' interest in mathematics and academics in general and their level of mathematics anxiety. College students who valued education and were interested in mathematics tended to be less afflicted with mathematics anxiety. Hembree's (1990) meta-analysis of 5th through 12th grade mathematics students supported this finding.

In other studies of 7th through 12th graders, results were opposite. Mathematics anxiety was lower in students who did not value mathematics (Meece et al., 1990; Wigfield & Meece, 1988). However, students with low perceptions of their own mathematics skills experienced more anxiety than their more confident counterparts (Meece et al.). Since the participants in my study were mostly freshmen, it is important to note that among 7th through 12th graders, 9th graders reported the highest levels of anxiety (Hembree 1990; Wigfield & Meece).

Mathematics Anxiety Rating Scale

The most frequently used instrument for measuring mathematics anxiety is the Mathematics Anxiety Rating Scale, or MARS. It was developed in 1972 by Dr. Richard Suinn (Wigfield & Meece, 1988) and offered strong reliability and validity. Ten years later, Suinn and Edwards developed a version of the MARS to be used to assess mathematics anxiety in adolescents. The MARS-A was created by adapting the wording of the MARS and changing some of the situations to make them more relevant to junior and senior high school students (Suinn & Edwards, 1982). Students with high MARS-A ratings demonstrated lower performance in their mathematics classes than students with lower MARS-A scores (Suinn & Edwards). Therefore, on average, students placed in the lowest level of Algebra I might be expected to have higher MARS-A scores than students in the highest level. Suinn's (1979) MARS-A normative data by gender are displayed in Table 1.

The MARS-A has been criticized because of its unequal weighting of two different components in mathematics anxiety: numerical anxiety and test anxiety (Wigfield & Meece, 1988). On the MARS-A, 89 of the scenarios presented address numerical anxiety while only 9 items pertain to test anxiety.

Table 1

Suinn's Normative Data

	7th, 8th, and 9th grade		10th, 11th, and 12th grade	
Percentile	Boys	Girls	Boys	Girls
5 %	119	126	119	134
10 %	131	137	132	137
20 %	147	152	147	155
30 %	160	168	162	168
40 %	176	184	174	179
50 %	193	200	188	192
60 %	211	214	200	202
75 %	241	248	230	232
80 %	252	260	240	246
95%	321	311	290	306

Strategies for Reducing Mathematics Anxiety

Many strategies have been suggested to eliminate or decrease mathematics anxiety. These include classroom or curricular whole-class interventions and psychological interventions. Psychological interventions can be classified as either behavioral or cognitive and occur in-class or out-of-class (Hembree, 1990). The behavioral treatment described as systematic desensitization, whereby students are exposed to increasingly stressful experiences in mathematics while employing relaxation techniques, has been found to reduce mathematics anxiety and test anxiety in elementary and high school students (Aiken, 1976; Hembree, 1988). While curricular and whole-class psychological strategies were generally ineffective, some cognitive treatments that promoted building confidence led to reduced mathematics anxiety (Hembree, 1988, 1990).

White (1997) investigated mathematics anxiety in high school Algebra I students. The treatment received by the experimental group consisted of a positive teacher attitude and use of cooperative learning activities. Despite these strategies, the experimental group maintained the same level of anxiety during the 12-week study.

Hackworth (1992) provided several specific strategies for reducing mathematics anxiety. These include journaling about feelings toward mathematics, learning study skills, finding ways to immediately address feelings of anxiety in class or while doing homework, and creating successful experiences to build confidence.

An example, although not a research study, of a recommended confidence-building treatment was to administer a “practice quiz” followed the next day by a similar or identical quiz (Hardiman, 2003). This was a cognitive treatment, since its purpose was to lessen student anxiety (Hembree, 1990). By training students on a specific set of problems one day and quizzing them on the exact same set of problems the next day, Hardiman’s experience in her own classroom showed that a teacher could facilitate student success and counteract previous experiences of failure. In Hardiman’s example the experience of success was what was most important, even if students were succeeding by memorizing answers on the first few quizzes. Her conclusion was that the benefits of the teaching quiz treatment could reach beyond higher student grades and positive attitudes toward mathematics to reduction in math anxiety and improved performance.

Wigfield and Meece (1988), on the other hand, suggested that addressing student lack of confidence in mathematics was not sufficient. Their research with 6th through 12th graders revealed that interventions should address student negative affective reactions to mathematics, not just the cognitive aspect of low confidence in mathematical ability. Thus, interventions that target both nervousness about mathematics and low confidence may be most effective (Wigfield & Meece).

Test Anxiety

Some researchers have proposed that mathematics anxiety is one form of test anxiety (Richardson & Woolfolk, 1980). Others contend that mathematics anxiety and test anxiety are related but are not synonymous (Dew, Galassi, & Galassi, 1983, 1984). Not only are some students fearful of problem solving and the general subject of mathematics, but also mathematics quizzes and tests elicit anxiety, especially those that are timed (Richardson & Woolfolk; Tobias, 1980). Richardson and Woolfolk pointed out that while “math anxiety” is a common phrase, students do not mention “biology anxiety” or “English-literature anxiety”. Presumably these subjects do not produce the same emotional response from students. A meta-analysis of test anxiety across grade levels indicates that test anxiety among high school students is highest in 9th grade and decreases through 12th grade (Hembree, 1988). This is noteworthy since the majority of the Algebra I students at the high school where I teach are ninth graders.

In Hendel’s (1979) study of the dimensions on mathematics anxiety, he determined that mathematics anxiety results more from assessment of mathematics skills than from the content itself. He recommended that students being tested for mathematics anxiety should not only complete a mathematics anxiety rating, but also a test anxiety survey. Therefore, the two scores could be compared in order to determine the true nature of the student’s anxiety (Hendel). In the current study, sources of student anxiety were investigated by doing a question analysis of the MARS-A results to determine which types of questions elicited the most anxious responses.

CHAPTER III

RESEARCH DESIGN AND METHODOLOGY

Theoretical Framework

To answer research questions, the researcher must choose the most appropriate methods. Quantitative methods of data collection are conducive to some studies, while qualitative strategies are suitable for others. However, recently there have been more studies coming out that utilize both methods. This section introduces mixed-methods research and continues with an overview of how naturalistic inquiry can be used as a framework for qualitative research. This section will also describe how the validity of a naturalistic study can be judged.

Mixed-Methods Research

Mixed-methods research is defined by Mertens (2005) as "a design... in which both quantitative and qualitative methods are used to answer research questions in a single study" (p. 292). Quantitative methods of data collection are used to verify or contest a theory that already exists. Qualitative strategies, however, are used to probe a topic more thoroughly. Thus, using a combination of methods allows one to both investigate current theory and generate further theory within the same study (Tashakkori & Teddlie, 2003).

In her textbook Patten (2004) stated that there are several key differences between qualitative and quantitative methods. Because qualitative research focuses on small groups or individuals, the sample size differs from that used in quantitative studies where a random sample is used. Another significant difference is the way in which the outcomes are expressed. In qualitative research, results are written descriptions, while in quantitative research the results are numerical and can be analyzed with descriptive statistics (Patten).

Naturalistic inquiry.

A specific paradigm used in qualitative research is naturalistic inquiry. It is an approach guided by the following principles: use of multiple viewpoints, study of cognition in the natural context, and the cycle of connecting theory confirmation and generation (Moschkovich & Brenner, 2000). In their study of high school students' learning of linear functions, Moschkovich and Brenner incorporated multiple points of view by paying close attention to the students' verbal and written responses as they learned about various concepts associated with the topic of linear functions. Emphasis was placed on noting when students' ideas differed from the researchers' conceptions of the material being studied (Moschkovich & Brenner).

The second principle of naturalistic inquiry, studying cognition in the natural context, is very appropriate in the field of education because students can be observed in their standard classroom environment. Moschkovich and Brenner (2000) conducted their research on students' understanding of linear functions in regular classrooms. They observed students working individually and in groups, and participating in class discussions (Moschkovich & Brenner).

The final component of naturalistic inquiry is the cycle of connecting theory confirmation with theory generation (Moschkovich & Brenner, 2000). This results in a spiraling pattern of inquiry because as data is collected and analyzed, the researcher can respond by adjusting the direction of the study or the methods of data collection. Moschkovich and Brenner were able to do this as they collected data that supported their hypotheses about student beliefs of linear functions. They used multiple methods of data collection and altered the assessments they were using as the study progressed (Moschkovich & Brenner).

Research validity.

In naturalistic inquiry, there are four guidelines that can be used to determine the validity of a study. These are: credibility, transferability, dependability, and confirmability (Erlandson, Harris, Skipper, & Allen, 1993; Moschkovich & Brenner, 2000). Credibility relates to internal validity and the truthfulness of the data in a particular context. Erlandson et al. offer several strategies that can be used to achieve credibility within naturalistic research. These techniques include studying a situation over a long period of time, and triangulation.

Transferability pertains to external validity, or generalizability (Erlandson et al., 1993; Moschkovich & Brenner, 2000). Context is an important part of evaluating transferability because it determines whether or not findings can be applied to other situations. To address transferability, sampling within and thick description should be used (Merriam, 1995).

Dependability, or consistency, refers to whether or not a study can be replicated (Erlandson et al., 1993). A way for a naturalistic researcher to ensure dependability is to use multiple methods of data collection and to provide documentation.

The final standard of naturalistic research, according to Moschkovich and Brenner (2000), is confirmability. Naturalistic research is unique in that the researcher does not remain completely removed from the study. Rather, the role of the researcher and the researcher's biases must be described as part of the investigation (Moschkovich & Brenner).

Emerging Research Design

The nature of qualitative research is that it sometimes requires re-adjustment during a study. Cavallo (2000) described this need for flexibility in research design. He stated that because context has such an important role in a study, there is no way to predict how a particular sample might respond. Therefore, the researcher must be ready to make changes to the research design as needed to fit a particular context. In my study, the design changed as the results of the intervention became apparent. The interview questions became more significant and were tailored to fit the questions that emerged. This section describes the participants, context, instruments, and procedure used in my research.

Participants

Eighteen high school Algebra I classes at a Midwestern, urban public high school of approximately 1700 students participated in this study. Before the school year began, I asked the seven other Algebra I teachers in my department if they would be willing to administer the Mathematicsitude Survey and the MARS-A to their students. All of the Algebra I teachers volunteered to participate in the study by administering the survey and the MARS-A in all of their Algebra I classes. Students ranged in age from 14 to 18 and were mostly freshmen. Approximately 19.5% of the students at the school were African American, 9.5% were Hispanic, 60.1% were white, 4.2% were Asian, 3.8% were Multi-Ethnic, and 2.9% were American-Indian ("Our School: Who We Are", 2006; KSDE, 2005). According to online data, 60.45% of the students at my school were considered economically disadvantaged while 57% of the students received free/reduced lunch (“Our School: Who We Are”; KSDE).

Context

The district of which this school is a part requires three credits of mathematics for graduation. Most freshmen take either Algebra I or Geometry. There is a small group of ninth graders who have already earned Algebra I and Geometry credits, so they enter Algebra II. The 2005 school year was the first in which the freshman Algebra I students were divided into three tiers based on their eighth grade Orleans Hanna test scores (C. Gales, personal communication, August 30, 2005). Students who had the lowest scores, between 0 and 40, but had regular attendance were placed in tier 3. The school's Mathematics Department goal for the tier 3 classes was 15-20 students in a class, so that there could be more one-on-one teaching. Tier 1 and 2 classes ranged in size from 22 to 35 students. Students who scored between 41 and 68 were placed in tier 2 and those with scores between 70 and 100 or who had irregular attendance or previous discipline problems were placed in tier 1. Although this organization system placed the highest scoring students in classes with students who had low scores and poor attendance and or poor behavior, it did make the tier 3 classes manageable and give students in those tier 3 classes the opportunity to be successful. Some teachers were reluctant to teach the tier 3 classes at first, but by keeping class sizes small and by reducing the potential for discipline problems, teacher concerns were lessened. Tiers 1 and 2 used the same textbook, but tier 2 students met every day for 90 minutes while tier 1 students met every other day for 90 minutes. Tier 3 classes met every day and used a smaller textbook written at a fifth grade reading level. There were 50 tier 1 students, 52 tier 2 students, and 21 tier 3 students who took the MARS-A.

Instruments

In order to include multiple sources of data, several methods were used to collect information on students' mathematics dispositions. All the students in my tier 1 and tier 3 classes wrote autobiographies at the beginning of the school year. One component of the autobiography was the students' descriptions of their mathematics background. These provided general insight into students' prior mathematics experiences and feeling about mathematics in general.

The second instrument was the Mathematicsitude Survey adapted from Furner and Duffy's (2002) "Mathitude Survey." Only slight formatting changes were made to the survey, which provided sentence stems to which students responded. The prompts included: "favorite thing in math," "favorite teacher in math," "if math were a color," and "if math were an animal." Questions 9 and 10 were true/false questions about whether "math stresses [the student] out" and whether the student perceives him/herself to be a good math problem solver. There was space for the student to explain his/her answer. All Algebra I teachers at the school were asked to give the Mathematicsitude Survey to their students.

The third data collection instrument was the Mathematics Anxiety Rating Scale for Adolescents. All Algebra I students were given class time to complete the initial MARS-A. The tier 3 post-MARS-A was also administered during class. The MARS-A was adapted by Suinn and Edwards (1982) from Suinn's original Mathematics Anxiety Rating Scale and consists of 98 items. The items present both real life and school-related situations involving mathematics. For each situation, students rate how anxious the scenario would make them feel: not at all, a little, a fair amount, much, or very much. The answers are assigned a value of 1 through 5 so that each student receives a numerical score between 98 and 490. A higher score indicates greater anxiety. Each student is then assigned an anxiety percentile ranking based on Suinn and Edwards' (1982) normative data.

Only students in my tier 3 class completed the MARS-A as a posttest after they had received a 12-week intervention designed to reduce their anxiety. All other students filled out the MARS-A only as a pretest to determine the initial level of mathematics anxiety in the school. At three points during the 12 weeks in which the treatment occurred, students in the treatment class were asked to reflect on their feelings of anxiety before or after a quiz. The reflection prompts were presented to students on the back of their quizzes and were completed independently in class.

Finally, after the treatment period, I conducted interviews with individuals in my tier 3 class. Six students: two from each extreme of the anxiety rating scale pretest, one who had the highest posttest score, and one who had the largest decrease in MARS-A score from pretest to posttest, were interviewed during class time outside of the classroom. These interviews were conducted after the MARS-A posttest, so that they would not influence its results. The responses of students were taped, transcribed, and analyzed. Each student was asked the following series of questions:

1. Imagine yourself doing math either in or out of school. What does it feel like?
2. Are you the type of person who does well in math class? Why or why not? (Furner & Duffy, 2002)
3. How much time did you spend studying the weekly pre-quizzes to prepare for the quiz the next day?
4. Did you ever think about a quiz when you were at home?
5. How do you feel about math this year compared to last year? Why?
6. Do you feel any differently toward math now than you did at the beginning of the semester?
7. If you know you have a test in some subject, which subject stresses you the most?
8. Do you ever get nervous before one of the weekly quizzes?
9. Do you get nervous before a chapter test in this class?

Procedure

Data were collected throughout one semester. In all of my Algebra I classes, my two tier 1 classes and one tier 3 class, the first assignment for students was to write an autobiography including three components: personal information, i.e., hobbies and family; mathematics background; and educational goals.

Over the ensuing few weeks, all Algebra I teachers in the school taught from chapter one from the district-adopted textbook, *Algebra 1* (Bellman, Bragg, Charles, Handlin, & Kennedy, 2004). Tier 3 classes used a different text, *Algebra 1* (Dixon, Kamat, Thompson, & White, 2001). The day after students received their chapter 1 test scores and discussed the test in class, they completed the Mathematicsitude Survey in class. In a department meeting, teachers were given a class set of surveys and were instructed to tell students to take the surveys seriously even if the questions seemed funny. Teachers were also advised to discuss the meaning of the word "anxious," which I described as "feeling nervous or uncomfortable in a particular situation," with their students and to answer any other definition type questions that students might encounter during the test. Within the next three weeks, teachers were supplied with a class set of MARS-A booklets. Each teacher administered the survey to his or her own class.

The Mathematicsitude Survey and the MARS-A were purposefully administered early in the 18-week semester for several reasons. First, since the MARS-A served as a pretest for the treatment group, it was administered early to allow 12 weeks for the treatment and ensuing posttest before the end of the semester. During the first two weeks of school, teachers work on community-building activities and introductory material. Students usually have less homework during that time. Therefore, I chose not to administer surveys until after the first test so that students would have a more realistic perception of their feelings in Algebra I. The surveys were not to be completed the day of the test or the day on which students received their scores, as these may have been times of heightened anxiety or dislike of mathematics for some students. Teachers were asked to hand out the surveys one or two class periods after students had received their scores from the first test.

As shown in Table 2, eight tier 1, six tier 2, and four tier 3 classes completed the MARS-A and Mathematicsitude Surveys. The data from those classes were used to determine the scope of mathematics anxiety in Algebra I students. Only responses from students who agreed to take part in the study and who received parental consent were included in the study.

Table 2

Number of Classes Participating in Each Part of The Study

	Autobiography	Mathematicsitude Survey	Pre-MARS-A	Post-MARS-A	Intervention
Tier 1 classes	2 did 6 did not	8 did	8 did	8 did not	8 did not
Tier 2 classes	6 did not	6 did	6 did	6 did not	6 did not
Tier 3 classes	1 did 3 did not	4 did	4 did	1 did 3 did not	1 did 3 did not

Intervention

My tier 3 class was the only class that received the intervention. There was no control group. The Monday following the administration of the MARS-A to my entire tier 3 class, this class was given the six-question pre-quiz shown in Appendix B. The questions were pre-printed on a half-sheet of paper that was distributed to all students. Students were instructed to complete the questions independently. Then volunteers worked the problems in front of the class on the interactive white board. As they did the problems they explained why they chose to add or subtract and why they assigned a positive or negative sign to their answer. The first two questions were addition of single and double-digit positive numbers. The third and fourth questions required addition of single and double-digit negative numbers. The final two questions involved addition of two numbers with opposite signs. Addition of integers was chosen as the first quiz topic because it was also one of the topics tested on the first chapter test.

On Tuesday, following the pre-quiz, after their bell-work, students were asked to take out their pre-quiz and to study it. Volunteers recalled the rules for addition of integers. Students then turned in the pre-quiz and received the same questions as a quiz. After the quiz, each student received a note card on which to reflect on the questions: “How did you feel when you arrived in class and remembered that there would be a quiz today? How did you feel when you saw the quiz questions?” After the fifth quiz, students were asked to respond to the questions: “How did you feel when you saw the quiz questions?” and “How well-prepared were you for this quiz?” After the 12th quiz, students answered the following questions: “How did you feel last night when you looked in your agenda and were reminded about today’s quiz? “ “How confident will you feel when you have the next quiz?” and “How do you think the weekly quizzes affected your grade in the class?”

The pattern of Monday pre-quizzes and Tuesday quizzes continued for the ensuing 11 weeks. The quiz topics were: subtraction of integers, multiplication of integers, division of integers, addition of fractions, subtraction of fractions, multiplication of fractions, division of fractions, addition of decimals, subtraction of decimals, multiplication of decimals, and division of decimals. The questions on the first four pre-quizzes and quizzes were exactly the same. On the next four quizzes, one number in each question differed from the pre-quiz, although the concept being assessed remained the same. On the last four quizzes, the format of each question was unchanged, but the actual numbers differed from the pre-quiz. The day after the 12th quiz, the MARS-A was re-administered to ascertain whether students’ anxiety ratings had changed since the pretest.

During the 12-week intervention period, students took the practice quizzes and quizzes individually. Student desks remained in rows. Although students did not work together on the quizzes, they did have opportunities to work together during other regular class activities and games. Also, when the class reviewed after the practice quiz and before the actual quiz, students could help each other or offer insights as they worked problems on the board in front of the class.

CHAPTER IV

RESULTS

Scope of Mathematics Anxiety

The first means of gathering data about student attitudes toward mathematics was the math autobiography that each of my Algebra I students wrote at the beginning of the semester. When students wrote about their previous experiences in mathematics classes, their opinions were clearly positive or clearly negative. Of the 26 students who wrote autobiographies and obtained permission to participate in my study, only 9 said that they liked math or had done well in previous math classes. The other 17 students wrote about their frustrations or struggles with math. Only a few students blamed their teachers for their lack of success. Although the autobiographies gave insight into student attitudes towards mathematics, they did not specifically reveal information about mathematics anxiety.

The first objective of this research was to determine the prevalence of mathematics anxiety among Algebra I students in the high school where I teach. The hypothesis was that since these students are not excelling in mathematics, they would either report at least moderate levels of mathematics anxiety, or the opposite: mathematics apathy. The results of the MARS-A administered at the beginning of the school year are shown in Table 3.

Table 3

August MARS-A Scores

Tier	Mean MARS-A score	*n*
1	222.8	50
2	202.8	52
3	209.9	21
All 3 combined	211.8	123

According to Suinn's (1979) normative data, shown in Table 1, a mean score of 211.8 indicates mathematics anxiety at or above the 60% level. Suinn suggested that the 60% level was a "modest" amount of anxiety while the 75% level could be used to signify students' eligibility for a mathematics anxiety intervention of some type. A closer examination of the MARS-A scores for all three tiers combined revealed that 50% of the Algebra I students participating in the study were reporting anxiety levels at the 75% level or above. This finding is in accord with Hackworth's (1992) statement that 50% of the adult population experiences math anxiety. He further suggested that most adults have suffered from this anxiety for over 10 years. Thus, mathematics anxiety is a significant problem in my high school as in other schools (Hackworth, 1992; Ho et. al, 2000; Richardson & Woolfolk, 1980; Tobias, 1993). It is important to keep in mind, however, that the standard deviation for the MARS-A scores in my study was 67.08, indicating a great amount of variation among students' anxiety scores.

Test Anxiety

As I scored the MARS-A, I noticed that many students reported more anxiety towards statements #74 through 86 on page 7 of the MARS-A booklet. A closer look at these questions revealed that several of them pertained to taking a test in a mathematics class. Thus, although the MARS-A was criticized for emphasizing numerical anxiety over test anxiety, the test anxiety component stood out when the scores were scrutinized (Wigfield & Meece, 1988). Table 4 shows the MARS-A statements which received the highest anxiety ratings. Of these 10, 7 have the word "test" or "examination" in them.

Table 4

Top Ten Anxiety-Evoking MARS-A Statements

Sum of anxiety-ratings	Question number and MARS-A statement
369	#85 Receiving your final math grade on your report card
363	#76 Thinking about an upcoming math *test* five minutes before
361	#54 Taking an *examination* (final) in a math course
353	#75 Thinking about an upcoming math *test* one hour before
349	#78 Waiting to get a math *test* returned on which you expected to do well
333	#33 Being called on to put a problem on the board when you are not sure your answer is right
327	#64 Deciding which courses to take in order to come out with enough credit hours for promotion or graduation
326	#58 Studying for a driver's license *test* and memorizing the numbers involved, such as the distances it takes to stop a car going at different speeds
317	#74 Thinking about an upcoming math *test* one day before
311	#79 Waiting to get a math *test* returned on which you expected to do poorly

While the MARS-A scores provided information on mathematics anxiety, student responses to the Mathematicsitude survey gave insight into how students felt about mathematics is general. Responses to the animal and color associations with math varied widely. Perhaps Furner and Duffy (2002) were using these questions as distracters or as a means of refocusing respondents. Although the qualitative data on animal and color associations with mathematics was difficult to interpret, some trends appeared. Of the12 students who represented mathematics with the color blue, only 4 of those said they were not good at problem solving and that mathematics was stressful for them. I think of blue as a cool or tranquil color, so it follows that students who are comfortable in a mathematics class might represent their feelings with the color blue. Students who felt anxious about mathematics, on the other hand, most commonly represented the subject with the colors pink, red, yellow and black. Pink, red and yellow seem warmer, and red and yellow are frequently associated with danger or warning signs in our culture. Sometimes black also has a negative connotation, especially when paired with an alligator or snake, as several students wrote.

I looked for a relationship between students' perceptions of their problem solving abilities and their level of stress resulting from mathematics. Generally, if students felt that they were good problem solvers, they stated that mathematics did not stress them out. Of the 63 completed surveys, 17 (27%) students responded this way. The converse was also true; students who felt that they were not good at problem-solving reported that they found mathematics to be stressful. Thirty-one out of 63 (49%) students fit this trend. The other 15 students (24%) either found mathematics stressful and were good problem solvers, or felt that they were not good at problem solving, but mathematics did not stress them out.

Not all students responded to the stems "if math were a color…" and "if math were an animal…" On the other survey responses, three themes emerged: anxiety-related statements including the words stress or stressful; negative statements including dislike, hate, frustrated, or not good; and apathetic statements of boredom. Table 5 shows these results.

Table 5

Mathematicsitude Survey Themes (n = 70)

Keywords in response	Number of responses	Percentage
Stress, stressful	23	32.9
Dislike, hate, frustrated, not good at	17	24.3
Boring	5	7.1

Intervention

For my tier 3 class, the scores from their pre MARS-A and their post MARS-A were compared. These results are shown in Table 6. During a follow-up interview with Student Alpha, a fictitious name for student #111, I realized that she had misunderstood the meaning of “anxious” on the MARS-A. Student Alpha had thought of anxious as excited. Thus, I did not use her scores when calculating the mean pre- and posttest ratings. The pretest mean was 226, while the posttest mean, after the 12 weeks of intervention quizzes, was 212.7. According to Suinn’s (1979) normative data for ninth grade students, a moderate or 60% level of anxiety is represented by a MARS-A score of 201 while a score of 229 indicated the 75% level. Thus both the pre- and posttest means for the tier 3 class fell between the 60% and 75% levels. These results were similar to those of White (1997), who found that after 12 weeks of treatment, the MARS test scores for both her treatment and control groups remained unchanged.

Table 6

Pre and Post MARS-A Scores for The Tier 3 Intervention Class

Student	MARS-A Pre	MARS-A Post	Change in MARS-A score
111	378	98	-280
112	347	315	-32
113	309	204	-105
107	303	319	+16
106	297	204	-88
114	260	207	-53
110	179	178	-1
109	162	108	-54
105	158	194	+36
108	139	265	+126
115	106	133	+27

Not including Student Alpha, six students' MARS-A scores decreased after the intervention and four students' scores increased. Before the intervention, 5 of the 10 students had MARS-A scores at the 75% level or greater. After the treatment, only three students indicated MARS-A scores at the 75% level or above. The mean change in score was a decrease of 13.3 points and the standard deviation was 68.97, indicating a great amount of variation in pre- and posttest scores among the 10 participants. The sample size was so small that the outlier scores greatly affected the mean. The decrease of 13.3 points was even less significant in light of the fact that there were 98 questions on the rating scale. To compare the pre and posttest scores, a correlated groups *t*-test was conducted. The difference between the pretest and posttest means was statistically insignificant ($t(9) = 6.10$, $p = .557$) implying that the participants' level of mathematics anxiety was not significantly lower after the treatment (*M* = 212.7) than before the treatment (*M* = 226.0). This may have been due to the great amount of variation in the students' scores, as well as the low number of students participating in the intervention part of the study. Because it was a tier 3 class, there were only about 18 students enrolled in the class. Of these, 11 received parent permission to participate in the study. Thus, because there were so few students participating in the intervention, no generalization should be made from the results. However, the small number did allow for further analysis using other methods of data collection.

To further investigate student anxiety, the tier 3 quiz reflections were analyzed. My first inquiry was "Why did anxiety not decrease more substantially after the confidence-building quizzes?" I was perplexed by students who wrote that they felt unprepared for the quizzes, even though they had done a practice quiz the previous day and some review problems immediately before the actual quiz. There seemed to be two main types of students revealed in the reflections: students who knew what to expect on the quizzes, and those who did not. Of the students who felt prepared for the quizzes, some of them either prepared by studying the practice quizzes or by reviewing the general steps required to solve each particular type of problem, i.e. converting to a common denominator or adding integers. Students who felt unprepared reported feeling that they were going to do badly on the quizzes and that the quizzes made their grade drop. These responses seemed to reflect passivity as though these students felt they had no control over their quiz preparation or scores (Sembera & Hovis, 1993; Tobias, 1993).

Qualitative Probing to Further Understanding of Findings

Further insights were gained from the individual interviews with six of the tier 3 participants. Three interviewees stated that their Algebra I class had become easier since August while the other three reported the converse. The three who perceived that the class had become easier seemed to have experienced attitude changes including studying more and getting more out of what they were learning. The three who felt that the class had become harder said that the material had become more difficult.

Student Beta, a fictitious name for student #115, was a male in my tier 3 class. He began the semester strongly with an A or B. Gradually he fell behind and multiple absences caused his overall grade to drop to a C for the rest of the semester. Student Beta seemed to maintain a passing grade without much effort. In the final interview, he commented that his uncle had taught him division when he was 5 and that most of his family had “book smarts.” Thus Student Beta entered the class with a significant amount of prior knowledge and although he often paid little attention in class, he managed to skim the textbook and complete the assignments.

With a score of 106, Student Beta had the lowest pre-MARS-A score, indicating the least amount of mathematics anxiety in the class. His posttest score was 133 – the second lowest of the posttest scores for that class. When asked why he was not “stressed about math,” Student Beta responded that it is part of his personality to just do his best and redo things if necessary. He knew that he could retake tests in my class, so there was always a second chance. On each of the quiz reflections, he responded that he was confident; felt prepared, and felt that the quiz grades were helping his grade.

I had expected that Student Beta would quickly recognize the similarities between the pre-quizzes and the actual quizzes the following day. However, he said that he had not noticed that the quizzes and practice quizzes were the same or different because he “just knew how to do them.” He said he did not focus on the specific questions, but rather on remembering the rules for how to do the operations. While other students worried about specific questions, this student calmly and methodically applied the rules he had learned for approaching each type of problem.

Was Student Beat not anxious because he knew how to do the problems, or was he able to think clearly because he was not anxious? I do think he entered the class with confidence in his abilities and in his prior knowledge. In this characteristic, Student Beta differed greatly from Student Gamma (student #112).

Student Gamma had the highest pre-MARS-A score of 347, and the second highest posttest score of 315. This student, a freshman female, fluctuated between a B or C grade at the beginning of the semester. I noticed that when Student Gamma did well on an assignment or a quiz, she seemed very excited. Gradually her grade slipped to a low or middle C. One month into the semester, I met with her because she wanted to come in and study with me before retaking a test. Student Gamma had failed the test, but when I wrote out some review problems, similar to those on the test, she did all of them correctly without much help. I began to wonder what was different about the practice setting and the test setting. I asked her how she felt when she looked at a test in front of her and she replied, "I think I'm gonna flunk because I always flunk tests." During Student Gamma's interview after the last intervention quiz she commented that she studies for tests, "but [she] just blanks out when [she] gets the test." We continued reviewing and she continued to do all of the problems correctly. I wrote some similar problems on the back of the paper on which we were reviewing and asked her to do them as well. I made up problems like the test problems, but with different numbers. Finally, I created a second version of the test and she answered all questions correctly. At that point I exclaimed, "Look, you just retook that entire test and scored 100%!" I apologized to her for tricking her into retaking the test without knowing it. It was apparent that Student Gamma could do the problems, as long she did not see the anxiety-provoking title "TEST" at the top of the page.

Student Gamma continued to show signs of increasing confidence. The day after the third intervention quiz, I returned the quizzes with each students' grade written at the top in bright pink ink. If the letter grade was an A or B, it was also written as a large letter beside the numerical score. When Student Gamma saw her quiz grade, she was triumphant, did a dance in her seat, and asked, "Can I take this home to show my daddy?" I allowed her to take it home. She scored 100% on the division quiz the next week, so I let her take it home too. During the first two months of the semester, Student Gamma never volunteered to solve problems on the overhead or the white board in front of the class, although other students eagerly offered to do problems each day. Finally, the day after the fourth intervention quiz, the students were working on a challenging assignment. Student Gamma asked if she could do the last question on the board. She quickly worked the problem in her notebook and then asked me to check her answer. She had to make one small correction. She then proudly wrote the solution on the board in front of the class. After that, Student Gamma frequently asked to solve at least one of the bell-work problems each day.

In the final interview, Student Gamma was asked about the experience of being tricked into retaking a test. She responded that she thought "it was cool to retake it without knowing it." I wondered if she felt anxious on tests in other classes and she replied that she "[gets] stressed in other classes too, but worse in math, cause [she] thinks [she's] gonna fail it." She also commented that she thought she had gotten better at math and feels more confident in herself this year. She said, "Last year I never did any problems on the board that you could go up there and do, but [now] I know I can go up there and get help if I need it." Student Gamma epitomizes Tobias' (1980) description of a math-anxious student whose fear is rooted in being embarrassed by making mistakes when asked to work a problem in front of the class and in timed tests and quizzes that emphasize the right answer.

Student Alpha had a much different attitude toward mathematics and math classes. She started out well with an A in the class. She sometimes did not quite follow directions on assignments, but still managed to catch on quickly. Early in the semester Student Alpha often complained that the class was too easy and once threatened that if she was not challenged, she might get bored and quit trying.

When Student Alpha took the MARS-A pretest, she scored over 300, but when she took the posttest, she scored just 98. In the follow-up interview, I asked her if she felt less anxious 12 weeks into the semester than she had at the beginning. She said she did not get nervous at all before math tests in this class. I began to wonder about her pretest score. Upon further questioning, I realized that Student Alpha had misunderstood the meaning of the word "anxious" on the pretest. She thought it meant excited and eager, rather than nervous. How did she not understand when I had talked about the definition of "anxious" and had given an example from my own life? Perhaps Student Alpha had not been paying attention simply because she was not engaged in the class and was not concerned about the survey. Although she seemed disengaged in class, she reported in the interview and in her reflections that did study regularly at home before quizzes and tests.

CHAPTER V

DISCUSSION

The following section is comprised of three parts. The Summary of Results constitutes a report of both the quantitative and qualitative data analysis, including comparisons with the results of some other studies. In the second subsection, the quality of this study is explored in terms of its validity as well as its limitations and the researcher biases. Implications for Further Research and Practice is the closing subsection. It includes not only suggestions for ways that the study could be extended but also questions that arose out of this study.

Summary of Results

The purpose of this research was to determine the scope of mathematics anxiety in Algebra I students at an urban Midwestern high school. A total of 123 students participated in this part of the study. Other teachers in my department showed some interest in the research. Additionally, one teacher changed her teaching practices as a result of the research. Her experience is described at the end of the *Summary of Results* section. The second goal was to implement an intervention with one class of students to investigate whether or not their mathematics anxiety scores would be lowered. The group which received the intervention was a tier 3 class consisting of 11 participants. They received the intervention over 12 weeks during the fall semester. The mixed-methods approach allowed me to quantitatively determine the baseline prevalence of mathematics anxiety at the school and then to follow-up with a qualitative exploration into the mathematics anxiety of students in one particular class.

The results of this research indicated that mathematics anxiety is a concern among Algebra I students at my high school. Of those students who participated, 50% had anxiety scores within the range that Suinn (1979) considered eligible for interventions. A question-by-question analysis revealed that the most prevalent source of mathematics anxiety was test anxiety. This implied that students were fearful of being assessed on their mathematical skills.

While the research did indicate the presence of mathematics anxiety, it did not confirm the effectiveness of the particular confidence-building intervention of pre-quiz and quiz. Although the pre-quiz and quiz strategy worked for Hardiman (2003) in her classroom, it was not successful in this study. Some students did exhibit greater confidence at the end of the treatment period than at the beginning, but the change was not universal. They demonstrated confidence by their willingness to work problems in front of the class and by their eagerness to take some of the quizzes. It was interesting to observe the role of student interactions in confidence-building. Students shared their triumphs with the class and boasted to their classmates when they did well. When their classroom behavior revealed that they felt good about their success on a quiz, they wrote in their reflections that they had less anxiety about the next quiz. Tobias (1993) reported that anxious students attempted to coast along in their math classes without anyone noticing their shortcomings. I saw that the opposite was also true; when students did well they were proud of their successes and wanted their peers to know. Some students, however, experienced greater anxiety as the semester progressed. I believe that multiple strategies must be used to assuage mathematics anxiety, especially mathematics test-taking anxiety.

Several themes emerged from the Mathematicsitude Survey responses and the tier 3 reflections and interviews. The idea of the role of student beliefs about their own abilities or lack of abilities became apparent in the key words presented in Table 5. Many students wrote on the survey that they get frustrated when doing mathematics or that they hate or dislike it or are just not good at it. Perhaps they have already encountered the seemingly insurmountable mathematics problem described by Tobias (1993). Students who feel that they have power over their mathematics abilities are more likely to feel confident in themselves and to keep trying even when faced with a mathematical challenge (Pajares & Kranzler, 1995). On the other hand, at least 50% of my students may have a poor view of their mathematical abilities and, in turn, high anxiety and high frustration. If this is true, then carefully constructed confidence-building techniques may reduce anxiety and empower students to become more perseverant and less frustrated with math problems.

The tier 3 reflections revealed passivity among some students. I define passivity as lack of engagement and lack of participation in a class. Tobias (1993) also mentioned passivity as a factor relating to mathematics anxiety. Although she did not clearly define passivity, she described students who sat at the back of the room and coasted along using memorization, hoping that their peers and teachers would not notice their deficits in math. In an attempt to help students learn the material on the intervention quizzes, the class received multiple opportunities to practice and to seek assistance. Before the actual weekly quizzes, the class did the pre-quiz, had the opportunity to study overnight, and then did review questions in class immediately before the quiz. Volunteers were invited to work practice problems in front of the class. And yet, there were students who stated that they felt unprepared for the quiz. I thought I had given them every opportunity to prepare, but they seemed to not know what to expect on the quiz. Were they unmotivated to study, or did they not know how to study? Were they hoping to coast by unnoticed? Unlike Tobias' description of passive students, these students did not seem to use memorization as a coping skill to help them succeed on the early quizzes. By their disappointment at the negative effect of the quizzes on their grades, I suspect that the students wanted to do well, but did not know how to study. Thus, one way to reduce test anxiety might be to instruct students in study skills.

As I was preparing for this study and reading the literature on mathematics anxiety, I shared some of my research with my colleagues. When I discussed with a neighboring teacher what I had read and asked her if she would administer the Mathematicsitude Survey and the MARS-A to her classes, she was enthusiastic to learn more. She stated that a new awareness of mathematics anxiety and test-taking anxiety caused her to change the way she administered tests in her classes. In the past, she had always tried to create tension in the room during a test. She felt that she, personally, needed a certain amount of stress in order to take a test seriously and to perform well, so she had assumed that was true for her students as well. After learning more about the consequences and prevalence of mathematics anxiety, however, she realized that the stress she was generating could be detrimental to some students' performance. As a result of this realization, she changed her approach on test days and tried to help students feel comfortable and at ease (Pamela Nye, personal communication, September 30, 2005).

Quality of This Study

The quality of this study was judged in both the quantitative and the qualitative areas. The reliability and validity of the quantitative research were addressed first. Then the qualitative part was examined. For this part, standards for naturalistic research were used, since I had followed the principles of that paradigm. The first principle of naturalistic inquiry, use of multiple viewpoints, was important in the research because several sources were used to gather information about students and their feelings toward mathematics. The second principle of naturalistic inquiry, studying cognition in the natural context, was present in the research because I observed students in their usual classroom setting.

Validity

This study began with quantitative research about the scope of mathematics anxiety. Reliability was addressed by having other teachers participate in order to increase the sample size and by using Suinn's MARS-A test. Not only did Suinn and Edwards (1982) find the MARS-A to have a good reliability coefficient (>0.90), but also they found that there was a correlation between MARS-A scores and performance in mathematics classes. Students with higher ratings on the MARS-A had lower grades.

As I continued with the qualitative part of the study, I followed the paradigm of naturalistic inquiry. The validity of naturalistic research can be evaluated based on the four qualities of credibility, transferability, dependability, and confirmability. In my study, credibility was established through triangulation (Erlandson et al., 1993; Moschkovich & Brenner, 2000). The Mathematicsitude Survey and the MARS-A yielded quantitative data. Qualitative probings to confirm or refute the findings were done through case studies, student reflections, interviews, and my own documentation. The peer questioning of my colleagues also contributed to the credibility of the research. To ensure transferability, Merriam (1995) suggested the use of sampling within and thick description. Sampling within was done through the use of case studies after the intervention process with the tier 3 class. The multiple methods of data collection as well as the case studies created several layers of observation. Dependability was accomplished by using multiple data collection methods such as the Mathematicsitude Survey, student reflections, and my own reflective notes. Finally, confirmability was determined by maintaining an awareness of my own biases.

Researcher Biases

As a teacher researcher I reflected on the role of my emotions in my study. When students wrote in their reflections that they felt unprepared for the weekly quiz, I became defensive and took the lack of preparedness personally. I felt as though students were blaming me for not giving them enough training or practice in the required skills. However, I realized that while one student reflected before a quiz that they felt unprepared, another student in the same class noted that they felt very prepared because they had studied and had worked a review problem in front of the class. This contrast caused me to realize that I had offered opportunities for students to engage and study, but some students were apathetic and did not prepare or did not know how to take responsibility for their own learning and performance. I became aware that, as a teacher, I have a much greater tolerance for and patience with a student who suffers from mathematics anxiety than one who has a poor attitude or is apathetic. Although I believed that I could remain objective in my role as researcher, there were moments when the emotions which were connected with my role as teacher surfaced.

Limitations of This Study

Despite my carefulness with how this research was conducted, I had little control over the practices of other teachers and how they administered the Mathematicsitude surveys and the MARS-A. Even within my own classroom there were limitations. The tier 3 reflections were very short and did not always offer much insight into students' thoughts. Perhaps it was not that they were apathetic, but that they did not know how to articulate themselves. Of the 11 tier 3 students, two were enrolled in a special Language Arts class to remediate their reading and writing skills, four earned a C in their first semester of English I, one earned a D in English I, and one earned an F in English I. Low performance in English I could indicate low reading and writing competency. Low reading proficiency may have prevented students from correctly interpreting the questions on the MARS-A.

In the tier 3 intervention class, external factors seemed to directly counteract the confidence-building strategy. Although some students did well on the weekly quizzes used to build confidence, students still had to perform on unit tests. Students reported that the material studied became increasingly difficult over the course of the semester, so they felt anxious on the unit tests. During the 12–week intervention, the connection between the quizzes and the regular coursework was less obvious to students. Because the first quizzes and the first unit test focused on integers, students who did well on the weekly quizzes could feel prepared for the unit test. However, as the curriculum progressed through solving equations, but the quizzes covered operations on decimals and fractions, the connection was less obvious for students. I knew that students would encounter fractions and decimals in the equations they were solving, so practicing those skills in isolation would help them with the equations. Student reflections and interview responses indicated that students perceived the concepts on the confidence-building quizzes as distinctly separate from the regular coursework, so the intervention was not effective in raising student confidence levels on the unit tests.

Implications for Further Research and Practice

There is potential for further research stemming from this study. More information about mathematics anxiety in Algebra I participants should be gathered by doing a pre-MARS-A and a post-MARS-A with a larger sample of students. Anxiety data could also be collected periodically throughout the semester using the MARS-A or a shortened version. Since test anxiety emerged as a major factor in mathematics anxiety, it would also be useful to administer an evaluation of test anxiety, such as the Suinn Test Anxiety Behavioral Scale (1969) or the FRIEDBEN Test Anxiety Scale (1997). The latter would be particularly informative since it was developed specifically for adolescents (Friedmann & Bendas-Jacob, 1997).

By investigating the relationship between mathematics anxiety and test anxiety, the cause of mathematics anxiety in high school Algebra I students could be isolated. Whether further research shows that mathematics anxiety in high school students generally results from test anxiety, or whether we find that each individual's anxiety is unique, more research on treatment is necessary. Can a classroom-wide strategy be effective or do treatments need to be tailored to each student? Can a classroom teacher implement strategies to reduce mathematics anxiety in his or her classroom or must students be treated outside of the regular classroom setting? How much effect does a teacher's attitude have on students' mathematics anxiety? How much effect do parents' attitudes have on students' mathematics anxiety?

Not all of the intervention participants scored well on the quizzes, even when the pre-quiz and quiz were identical. This indicates that the weekly pre-quiz and quiz strategy may have been ineffective because the quizzes were too challenging for some students. In the research design, it was assumed that students had prior knowledge of basic operations on integers, fractions, and decimals. I hoped that with a small amount of review, all students would be able to score an A or a B on the quizzes. This was not the case. Even after individual help and review in class, some students still did not pass the quizzes. These continued failures counteracted the intended result which was to build student confidence.

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APPENDICES

Appendix A: Mathematicsitude Survey

Name: ____________ Age: _____ Date: _____

Mathematicsitude Survey

1.) When I hear the word math, I

2.) My favorite thing in math is

3.) My least favorite thing in math is

4.) If I could ask for one thing in math, it would be

5.) My favorite teacher for math is______________________________because

6.) If math were a color, it would be

7.) If math were an animal, it would be

8.) My favorite subject is ____________ because

9.) Math stresses me out: **True** or **False**. Explain if you can.

10.)I am a good math problem solver: **True** or **False**. Explain if you can.

Appendix B: Intervention Practice Quizzes and Quizzes

Intervention Practice Quiz and Quiz #1

Name: _____________ Date: ____

Adding Integers

1.) 7 + 12 = _____

2.) 6 + 8 = _____

3.) –2 + -10 = _____

4.) –3 + -20 = _____

5.) –8 + 5 = _____

6.) 10 + -2 = _____

Intervention Practice Quiz and Quiz #2

Name: _____________ Date: ____

Subtracting Integers

1.) 7 - 12 = _____

2.) 6 - 8 = _____

3.) –2 - -10 = _____

4.) –3 - -20 = _____

5.) –8 - 5 = _____

6.) 10 - -2 = _____

Intervention Practice Quiz and Quiz #3
Name: ____________ Date: ____

Multiplying Integers

1.) 7 • 12 = _____

2.) 6 • 8 = _____

3.) –2 • -10 = _____

4.) –3 • -20 = _____

5.) –8 • 5 = _____

6.) 10 • -2 = _____

Intervention Practice Quiz and Quiz #4

Name: ____________ Date: ____

Dividing Integers

1.) 12 ÷ 4 = _____

2.) 6 ÷ 3 = _____

3.) –10 ÷ -2 = _____

4.) –18 ÷ -9 = _____

5.) –24 ÷ 8 = _____

6.) 10 ÷ -2 = _____

Practice Quiz #5

Name: _____________ Date: ____

Adding Fractions Practice

1.) $\frac{1}{4} + \frac{3}{4} =$ ______

2.) $\frac{1}{8} + \frac{3}{8} =$ ______

3.) $\frac{1}{4} + \frac{1}{2} =$ ______

4.) $\frac{5}{8} + \frac{3}{4} =$ ______

5.) $\frac{2}{3} + \frac{1}{4} =$ ______

6.) $2\frac{1}{3} + \frac{7}{8} =$ ______

Intervention Quiz #5
Name: _____________ Date: ____

Adding Fractions Quiz

1.) $\frac{1}{4} + \frac{1}{4} =$ ______

2.) $\frac{1}{8} + \frac{5}{8} =$ ______

3.) $\frac{1}{8} + \frac{1}{2} =$ ______

4.) $\frac{3}{8} + \frac{3}{4} =$ ______

5.) $\frac{2}{3} + \frac{1}{2} =$ ______

6.) $1\frac{2}{3} + \frac{7}{8} =$ ______

Practice Quiz #6

Name: _____________ Date: ____

Subtracting Fractions Practice

1.) $\frac{3}{4} - \frac{1}{4} =$ ______

2.) $\frac{3}{8} - \frac{1}{8} =$ ______

3.) $\frac{1}{2} - \frac{1}{4} =$ ______

4.) $\frac{3}{4} - \frac{5}{8} =$ ______

5.) $\frac{2}{3} - \frac{1}{4} =$ ______

6.) $2\frac{1}{3} - \frac{7}{8} =$ ______

Intervention Quiz #6

Name: _____________ Date: ____

Subtracting Fractions Quiz

1.) $\frac{1}{4} - \frac{1}{4} =$ ______

2.) $\frac{5}{8} - \frac{1}{8} =$ ______

3.) $\frac{1}{2} - \frac{1}{8} =$ ______

4.) $\frac{3}{4} - \frac{3}{8} =$ ______

5.) $\frac{2}{3} - \frac{1}{2} =$ ______

6.) $1\frac{2}{3} - \frac{7}{8} =$ ______

Practice Quiz #7

Name: _____________ Date: ____

Multiplying Fractions Practice

1.) $\frac{3}{4} \bullet \frac{1}{4}$ = ______

2.) $\frac{3}{8} \bullet \frac{2}{3}$ = ______

3.) $\frac{1}{2} \bullet \frac{3}{4}$ = ______

4.) $\frac{3}{4} \bullet \frac{2}{3}$ = ______

5.) $\frac{2}{3} \bullet \frac{1}{4}$ = ______

6.) $2\frac{1}{3} \bullet \frac{7}{8}$ = ______

Intervention Quiz #7

Name: _____________ Date: ____

Multiplying Fractions Quiz

1.) $\frac{1}{4} \bullet \frac{1}{4}$ = ______

2.) $\frac{2}{3} \bullet \frac{1}{8}$ = ______

3.) $\frac{3}{4} \bullet \frac{1}{8}$ = ______

4.) $\frac{2}{3} \bullet \frac{3}{8}$ = ______

5.) $\frac{2}{3} \bullet \frac{1}{2}$ = ______

6.) $1\frac{2}{3} \bullet \frac{7}{8}$ = ______

Practice Quiz #8

Name: _____________ Date: ____

Dividing Fractions Practice

1.) $\frac{3}{4} \div \frac{1}{4}$ = ______

2.) $\frac{3}{8} \div \frac{2}{3}$ = ______

3.) $\frac{1}{2} \div \frac{3}{4}$ = ______

4.) $\frac{3}{4} \div \frac{2}{3}$ = ______

5.) $\frac{2}{3} \div \frac{1}{4}$ = ______

6.) $2\frac{1}{3} \div \frac{7}{8}$ = ______

Intervention Quiz #8

Name: _____________ Date: ____

Dividing Fractions Quiz

1.) $\frac{1}{4} \div \frac{1}{4}$ = ______

2.) $\frac{2}{3} \div \frac{1}{8}$ = ______

3.) $\frac{3}{4} \div \frac{1}{8}$ = ______

4.) $\frac{2}{3} \div \frac{3}{8}$ = ______

5.) $\frac{2}{3} \div \frac{1}{2}$ = ______

6.) $1\frac{2}{3} \div \frac{7}{8}$ = ______

Practice Quiz #9

Name: ____________ Date: ____

Adding Decimals Practice

1.) 1.03
+ 2.69

2.) 3.99
+ 4.683

3.) 1.235 + 66.94 =

4.) 0.0589 + 1.2721 =

5.) .989 + 2.45 =

6.) 10.785 + 4.630 =

Intervention Quiz #9

Name: ____________ Date: ____

Adding Decimals Quiz

1.) 1.08
+ 3.72

2.) 4.89
+ 2.785

3.) 2.374 + 72.390=

4.) 0.0744 + 2.3369=

5.) .787 + 3.62 =

6.) 11.375 + 5.542 =

Practice Quiz #10

Name: ____________ Date: ____

Subtracting Decimals Practice

1.) 2.69
-1.03

2.) 4.68
- 3.99

3.) 66.94 - 1.23 =

4.) 1.272 – 0.0951 =

5.) 2.45 - .7 =

6.) 10.785 - 4.9999 =

Intervention Quiz #10

Name: ____________ Date: ____

Subtracting Decimals Quiz

1.) 3.58
- 1.04

2.) 5.67
- 2.88

3.) 46.84 – 2.14 =

4.) 2.352 – 0.0841 =

5.) 3.36 – .8 =

6.) 15.774 – 4.8978 =

Practice Quiz #11

Name: ____________   Date: ____

Multiplying Decimals Practice

1.) 7.01
x 39

2.) 13.2
x 7.3

3.) 4.5 • 2.8 =

4.) 13.14 • 2.31 =

5.) 21.45 • 16.8 =

6.) 10.002 • .005 =

Intervention Quiz #11

Name: ____________   Date: ____

Multiplying Decimals Quiz

1.) 6.01
x 28

2.) 16.5
x 4.1

3.) 4.3 • 2.9 =

4.) 12.13 • 2.21 =

5.) 42.67 • 12.4 =

6.) 20.006 • .003 =

Practice Quiz #12

Name: ____________ Date: ____

Dividing Decimals

1.) $2\overline{)8.48}$

2.) $4\overline{)8.36}$

3.) $3\overline{)81.57}$

4.) $2\overline{)51.1}$

5.) 27.909 ÷ 3 =

6.) 0.0535 ÷ 5 =

Intervention Quiz #12

Name: ____________ Date: ____

Dividing Decimals

1.) $3\overline{)9.36}$

2.) $5\overline{)5.35}$

3.) $2\overline{)78.52}$

4.) $4\overline{)51.0}$

5.) 24.804 ÷ 4 =

6.) 0.0642 ÷ 6 =

Appendix C: Interview Questions

Imagine yourself doing math either in or out of school. What does it feel like?

Are you the type of person who does well in math class? Why or why not?

How much time did you spend studying the weekly pre-quizzes to prepare for the quiz the next day?

Did you ever think about a quiz when you were at home?

How do you feel about math this year compared to last year? Why?

Do you feel any differently towards math now than you did at the beginning of the semester?

If you know you have a test in some subject, which subject stresses you the most?

Do you get nervous before one of the weekly quizzes?

Do you get nervous before a chapter test?

mid and high pre-MARS-A Why did/do you feel anxious about math? (just tests? Working problems, playing a game? Dry erase boards?)

low pre-MARS-A Why do you think you aren't stressed about math?