

Reducing Test Anxiety in Math for Adolescents

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Table of Contents

List of Tables	iii
Abstract	iv
I. Introduction	1
Statement of Problem	1
Hypothesis	1
Operational Definitions	2
II. Literature Review	3
Test Anxiety	3
Achievement and Anxiety	4
Interventions and Strategies	6
Summary	8
III. Methods	9
Design	9
Participants	9
Instrument	9
Procedure	10
IV. Results	12
Changes in Identifying Correct Strategies	12
Identifying Specific Strategies	13
Pre- and Post-Test Score Changes	14
Effect of Strategies on Achievement	15
Conclusions	15

V. Discussion	17
Validity	17
Connections to Previous Studies	17
Implications	18
References	20

List of Tables

1. Number and Percent of Participants Indicating Correct Strategy between Pre- and Post-Test	13
2. Use of Strategies between Pre- and Post-Test	14
3. Improvements in Test Scores between Pre- and Post-Test	15
4. Change in Pre-Test and Post-Test Scores and Use of Correct Strategies	15

Abstract

The purpose of this study was to determine whether teaching problem-solving strategies would reduce test anxiety and increase math achievement for adolescents. A test created from Maryland State Assessment practice problems was the measurement tool. This study involved the use of a pre-test/post-test intervention design. A pre-test was given in February 2009. Subsequently, the intervention took place for a period of one month when test-taking strategies were taught. At the conclusion of the intervention, a post-test was given to the participants. Achievement gains were significant, though results were affected by various factors. More research in reducing test anxiety in math for adolescents as well as a longer study to analyze problem-solving strategies is needed.

CHAPTER I

INTRODUCTION

Many students believe that math is their worst subject and that they cannot be successful in their math classes. Similarly, students complain about taking math tests because the tests cause them to be nervous or anxious. Students have test anxiety for many reasons. Teachers frequently see students suffer from test anxiety, and even the best students report problems taking tests.

Math tests may seem to be more difficult for students than other tests because they require problem-solving skills. In social studies or science, students focus more on memorizing facts. For math tests, students must memorize formulas and rules, and then apply them to situations. Often, students are not sure what to do for each question, and instead of using a strategy, they are inclined to choose a random selection method, be it reasonable or not.

Statement of Problem

With so many standardized tests, reducing test anxiety, particularly in the area of math, is a major concern. Students admit to feeling anxious before tests. Research indicates that when teachers give students the same questions before a test, students perform well, but when identical questions appear on a test, students do not get them correct. The goal of this study is to help improve the achievement of adolescents in math by reducing anxiety.

Hypothesis

By reducing test anxiety in adolescents, math achievement can improve. This study hypothesizes that by directly teaching students test-taking strategies related to assessment content, their anxiety will be reduced. When teaching a math topic, teachers often explain processes, but in very specific contexts. There are overall math strategies that can be used,

particularly if a student is drawing a complete blank on a question. If students are enabled with a repertoire of simple problem-solving strategies, they can go through them and see which ones seem most appropriate. Therefore, teaching strategies directly linked to the test content should help students feel more confident before taking the tests.

Operational Definitions

Test anxiety is different from general nervousness. Students with test anxiety feel as if studying and knowledge do not matter for them on a test. Students feel as if tests are extremely difficult, and this anxiety affects achievement. Test anxiety can come from any length test, whether it is a short quiz or an exam. This kind of anxiety is situation-based and is different from general anxiety or trait-based anxiety. In addition, students can have test anxiety even with subjects in which the students excel. For this study, test anxiety is the main focus, although math anxiety may have effects on the test anxiety. Most participants prior to the study expressed difficulty with math. Statements included “I cannot do math,” “Math has always been my worst subject,” and others. Due to the time constraints of daily classroom interaction, reducing math anxiety is not as conceivable as reducing anxiety about math tests within a single research period.

CHAPTER II

LITERATURE REVIEW

This literature review examines interventions used for reducing anxiety, and the effects of test anxiety on the mathematics achievement of adolescents. Section one defines test anxiety and provides specific information about adolescents, using common threads from existing research. Section two compares tests and their methods of defining mathematics achievement. Section three connects achievement with anxiety, and section four discusses current interventions and strategies for overcoming anxiety.

Test Anxiety

There are multiple definitions of test anxiety. Some researchers use physical and cognitive symptoms to define test anxiety. The typical symptoms include distress, sweating, and an accelerated heart rate (Sena, Whitaker, Lowe, & Lee, 2007). These symptoms also connect with feelings of failure and low self-confidence. “These responses may lead to negative feelings and cognitions about testing situations” (p. 1). However, researchers recognize that anxious emotions are exhibited differently by each individual. Some people may not show the same signs of anxiety, and may suffer test anxiety in a more subtle way (Supon, 2004). According to A.J. Nitko’s *Educational Assessments of Students*, as referenced by Supon, there are three types of test-anxious students. One type lacks the abilities to study and organize information, the second kind fears failure, and the third kind thinks he or she studies well, but actually does not. Each type of student may need different interventions.

Another way of defining anxiety is using state and trait definitions, as developed by Spielberger and Vagg. “The test-anxious individual experiences more intense levels of state anxiety in each evaluative situation. State anxiety is viewed as the emotionality component” (as cited in Sena et al., 2007, p. 2). The state anxiety of the individual will bring out certain traits or

worry conditions from the individual's memories.

Researchers measure test anxiety with different scales, particularly the State-Trait Anxiety Inventory for Children (STAIC) scale. This scale is useful because it consistently demonstrates accurate measurement of anxiety (Seligman, Ollendick, Langley, & Baldacci, 2004). In order to use this scale, anxiety is defined using state and trait terminology from Spielberger and Vagg. The measures appear to be less accurate for monitoring the anxiety for boys, however, which “may be due in part to the effect of social desirability on boys’ reports and outward expressions of anxiety” (p. 563).

Test anxiety is a current topic in educational research. The attention is most likely due to the latest reforms in education that have focused on high-stakes testing (Carter et al., 2006). Tests are used to decide the future of students by determining diplomas or college acceptance. Adolescents see taking tests as a source of stress because the tests decide so much. Their family environment can also affect their level of stress and anxiety for tests (Peleg-Popko, 2004). Consequently, the prevalence of test anxiety appears to have increased. “More than 33% of students experience some test anxiety, and this has possibly increased over time” (Sena et al., 2007, p. 2). Now, researchers are exploring whether increased anxiety affects achievement on the tests.

Achievement and Anxiety

Many people have studied connections between achievement and forms of anxiety. Some of the studies focus on adolescents who have anxiety disorders. These are not as useful for studying the connections for average adolescents. Other studies look at math anxiety in general, and not just the kind that comes from tests. Tsui and Mazzocco (2007) discuss how math anxiety affects achievement, and how sometimes anxiety does not affect achievement at all. In their

study, when the math problems involved skills that were challenging for the grade level of the participants (such as fractions and percentages), the adolescents' anxiety did affect their performance. They also looked at achievement results from untimed and timed tests. Those with higher anxiety did not differ during timed tests, but on untimed tests, they took longer than children with lower anxiety. These adolescents may be "doubtful of their own ability when taking a math test" (p. 8).

Math anxiety can lead to problems later in life with career choices and college paths. If students are anxious during tests, and consequently perform poorly on them, they may feel they cannot be successful in a math-related career. The students in the Tsui and Mazzocco study were gifted children, so their anxiety may be different from normal students' anxiety. The natural skills of the gifted children may help them overcome their anxiety during tests. Assumptions from these children cannot be used for other groups of students without further study (Tsui & Mazzocco, 2007).

Other problems that can create anxiety on tests include students' learning and testing preferences. These preferences may lead to performance differences (Birenbaum, 2007). Some students prefer quick problems, and these students tend to perform worse than students who prefer problem-solving tasks. Teaching styles may also affect their preferences and affect their test anxiety. Students prefer teachers who are "clear, interesting, organized, and well prepared" (p. 750). Teachers who are disorganized may leave students feeling less prepared for assessments.

During tests, students with test-taking anxiety have two major problems. The first is that worry and other fearful thoughts distract them from the material they are trying to remember (Birenbaum, 2007). The second is that these students had trouble before the test organizing the

material, and thus have more limited knowledge of it. These students merely have anxiety because they never knew the material as well, so they should not be expected to perform well on the assessment anyway. During studies, it may be difficult to separate the two groups of test-anxious students. By focusing on learning preferences, Birenbaum hoped to help the second group of students learn the material correctly, and help the other students feel more prepared.

Interventions and Strategies

Throughout the literature on test-taking anxiety, there are a few common themes of interventions for reducing test anxiety. Some involve using programs, some include specific strategies for groups of students, and some use isolated strategies that could be grouped together in one program. Most of the interventions are used with isolated groups, such as adolescents with disorders, or college students. These interventions can be studied with other age groups and other kinds of adolescents to assess them properly.

Most interventions are long-term preparation strategies. These are strategies and programs that require long-term use prior to assessments. “Preparation for high-stakes assessment tests should be addressed much earlier in students’ academic programs” (Carter et al., 2006, p. 60). One early intervention is called Acceptance and Commitment Therapy (ACT). This intervention attempts to change how people think about their fears and anxieties because often people will evaluate events as “bad” or “awful,” providing them reasons to feel upset. In Zettle’s (2003) study, students with math anxiety were chosen, and all of the students are college students. This study administered ACT to individuals in lieu of a group setting, so it might not work as well in a classroom setting.

Birenbaum’s (2007) focus on learning preferences is another strategy that can be applied early. Teachers need to be aware of the learning preferences of their students, as well as

assessment preferences. There is some connection between learning strategies and assessment preferences. A teacher may not be able to assess the quality of students' learning strategies as easily as inquiring about students' assessment preferences.

While teaching, instructors should also be aware of teaching test-taking strategies. Generic test-taking strategies like watching the clock are moderately useful, but students seem to score better when "strategy instruction is more closely aligned to the specific types of problems that students will encounter" (Carter et al., 2006, p. 60). This kind of instruction needs to be in each lesson, showing students strategies for solving particular kinds of problems.

Another long-term strategy involves the family environment. Families that do not display a balance between individualism and togetherness seem to have more adolescents with higher levels of test and trait anxiety (Peleg-Popko, 2004). Peleg-Popko suggests adolescent counseling that addresses family issues to help these students. This is an intervention that is not as useful for the classroom because teachers cannot counsel students professionally.

Supon (2004) sums up many of the previous interventions by making suggestions for teachers. These suggestions include describing ways of studying, giving practice tasks that are similar to test questions, stressing the values of tests for improving learning, and remaining positive about tests. Supon references Collins' 1999 study, *Effective strategies for dealing with test anxiety: Teacher to teachers series*, which recommends anxiety management training for the worst of the test-anxious students.

Two other interventions involve more instant strategies. The first involves preparing "crib sheets" for students to use. Erbe (2007) suggests that reducing student anxiety overall with crib sheets can improve learning. For math in particular, much of the anxiety comes from memorizing formulas, and Erbe would rather provide the students with this kind of basic

information to allow the students to think more about higher-level math. This intervention is appealing, but it will not help students with many high-stakes assessments that do not allow crib sheets. The second instant strategy is providing immediate forewarning of test difficulty. In order to use this strategy, teachers must be aware of the level of trait anxiety their students have. Students with lower trait anxiety tended to perform better when told an exam would be difficult, and students with higher trait anxiety were the opposite (Weber & Bizer, 2006). This could prove difficult in a class with students of different levels of trait anxiety.

Overall, the different studies that used these interventions had various problems. Some of the main problems include the sample sizes (too small), the age-level of participants (not many with early adolescent students), and other aspects of the participants (having disabilities, or higher academic levels). It was rare to find studies on adolescent students in large classes with average abilities relating to test anxiety. Also, many of the scales are better suited for children with diagnosed anxiety disorders. There are also at this time not very many studies with math achievement and test anxiety as a focus. More research needs to be done in this field to determine an intervention program that can work for a large group of students. There does seem to be some connection between test anxiety and math achievement, but further research is needed to explore the depth and implications of the relationship between them.

Summary

There is research on test anxiety and achievement, but at this time, there are not many suggestions for strategies or interventions. In addition, the participants are either gifted or diagnosed with anxiety disorders. Research is needed for average adolescent students. This research should include an intervention to improve test anxiety. Then, any affects on mathematics achievement could be examined.

CHAPTER III

METHODS

Design

This study used a quasi-experimental design with a pre-test/post-test assessment strategy. The assessments were used to measure the effectiveness of the intervention, which included test-taking strategies.

Participants

The participants in this study were four middle school boys whose ages ranged from 11 through 15. This was a convenience sample because the participants were in the researcher's own classroom for the duration of the study. One class consisted of sixth grade students identified as having average abilities, and the other class was a group of eighth grade students identified as performing below their class average. These students were expelled from their home schools and sent to the alternative school used in this study as a consequence. The participants were at the school for approximately four weeks before this study began.

Instrument

The test designed for use in this study by the researcher included math problems matched to Maryland State Assessment (MSA) skills. All of the participants in this study are required to take the Maryland State Assessment (MSA) each year. This assessment includes multiple choice questions, grid-in questions, and essay questions known as Brief Constructed Responses (BCRs) and Extended Constructed Responses (ECRs). The test is given once annually with four parts, two for math and two for reading and writing. Results from the MSA determine a student's placement for the following year, as well as progress for the schools. Questions on this test come from a state curriculum that includes assessment limits. There is a database of sample

questions and assessment limits available to all teachers. This database was used to create a short test for the participants in this study.

The researcher-created test included problems challenging for both levels of students, and all problems required a strategy to solve them. The test was ten points, with one grid-in question, five selected response questions, and one extended constructed-response question. Along with the test, there was a strategy sheet that listed the five main strategy techniques for math problems. Participants would select which strategy or strategies they used for each question. They also had “None of the above” as an option.

Procedure

The researcher began with a pre-test for the participants. The participants had approximately fifteen minutes to take the test and to mark the strategy sheet. When the researcher handed out the papers, it was explained to the participants that this test was to see what they knew as an MSA review. The strategy sheet was a separate paper dispensed with the instruction to mark each strategy or strategies that they used to help them solve a problem. If the students had no idea how to solve a problem, they were instructed to mark the “none of the above” column on the strategy sheet.

Both groups participated in the pre-test, and it was given on a day when all participants were present so that the testing situations were uniform. Participants did not receive information on their specific results or strategies. After the pre-test, the researcher examined the strategy sheet to see which strategies were used most often and correctly. Guess and check was used the most frequently by students.

After the pre-test, students received strategy instruction each day. It began informally with suggestions during classwork problems. Then, after two days of informal instruction, the

participants began a new unit in class, and the warm-ups changed to include test-like questions. Students would take a few minutes trying the warm-ups on their own, and then would go over them as a class. Participants discussed strategies that were used. Two weeks later, students took a post-test that had the same questions from before, but with numbers and names changed.

CHAPTER IV

RESULTS

For this study, there were two sets of data collected: the strategies used, and the scores on the assessments. In analyzing the data, four primary characteristics were examined. First, it was determined whether there were changes between pre- and post-test in the percentage of participants identifying the correct strategies. Secondly, items where participants showed the most improvement in choosing the correct strategy were identified. Third, it was determined whether participants improved in their scores from pre-test to post-test. Finally, the researcher examined whether participants identified more correct strategies to make them more likely to improve pre-test to post-test. Overall, participants demonstrated improvement in each area. Additionally, identifying correct strategies increased test scores.

Changes in Identifying Correct Strategies

For the pre-test, at least one participant identified a correct strategy for five out of the seven questions. There was only one question on the pre-test where half of the participants used a correct strategy. Participants on two pre-test questions did not identify any appropriate strategies. Then, after the intervention, all seven questions on the post-test had at least one participant pick an appropriate strategy. For question five on the post-test, all participants picked a correct strategy. In two of the seven questions on the post test, 75% of participants identified a reasonable strategy (Table 1).

Table 1 Number and Percent of Participants Indicating Correct Strategy between Pre- and Post-Test

Question Number	Pre-Test		Post-Test	
	Number	Percent	Number	Percent
1	1	25%	3	75%
2	1	25%	2	50%
3	0	0	1	25%
4	1	25%	3	75%
5	1	25%	4	100%
6	0	0	1	25%
7	2	50%	2	50%

These results showed improvement in participant recognition of correct strategies to employ between pre- and post-tests. The majority of participants were able to identify correct strategies in three of the seven questions on the post-test. In looking at the strategies picked, participants mostly picked “None of the above” on the pre-test and rarely picked it on the post-test. Some participants did not pick any strategies on the pre-test questions, but only one question from all participants on the post test did not have a strategy picked by an individual (Table 1).

Identifying Specific Strategies

In examining specific strategies, some showed more improvement than others. Participants had the most difficulty identifying the “use examples” strategy. Between pre- and post-test, participants improved the most in their correct usage of the following three strategies: “use of pictures, lists, or tables”, “use words”, and “use guess/check” (Table 2).

Table 2 Use of Strategies between Pre- and Post-Test

Strategy	Number of items where Strategy was correct #/7 (total questions)	Number of Items when Participants Correctly Identified	
		Pre test	Post test
Use of Pictures, Lists or Tables	4/7	0	2
Use Rules	5/7	3	3
Use Words	2/7	0	1
Use Guess/check	3/7	1	3
Use Examples	3/7	1	0

Pre- and Post-Test Score Changes

All participants improved their test scores between pre- and post-test. Table 3 shows the change in test scores by participant. On the pre-test, the highest score was a 4 out of 10 possible points. On the post-test, the lowest test score was 5 out of 10 points, and the highest score, earned by two participants, was an 8 out of 10 points. The assessments were scored out of ten points, and then converted to percents. The mean for the pre-test was 27.5% with a standard deviation of approximately 8.292. Post-test scores had a mean of 70% with a standard deviation of 10. Individual and overall class test scores increased (Table 3).

Table 3 Improvements in Test Scores between Pre-and Post-Test

(Points are based on possible 10 points on Pre- and Post-Test)

Participant Number	Test Scores	
	Pre-test	Post-test
1	4	8
2	3	6
3	2	6
4	2	8

Effect of Strategies on Achievement

Table 4 Change in Pre-Test and Post-Test Scores and Use of Correct Strategies

Participant Number	Test Scores		# of Correct Strategies Used	
	Pre-Test	Post-Test	Pre-Test	Post-Test
1	4	8	1	3
2	3	6	2	4
3	2	6	1	5
4	2	8	0	4

Table 4 showed that all participants improved their test scores, and all participants employed more correct strategies at post-test than pre-test. Thus, an increase in test scores was tied to the increase in correct strategies. When questions were examined individually, participants were more likely to answer items 1, 4, and 5 on the post-test correctly, and were more likely to have used correct strategies. These three items shared their use of the strategy “use rules”. Items 4 and 5 also shared the strategy “use guess/check” (Table 4).

Conclusions

The analysis showed that there was significant improvement from pre- to post-test.

Participants were more likely to select correct strategies on the post-test than on the pre-test. Additionally, this improvement in strategy identification appeared to improve achievement for the post-test. Certain strategies were more correctly identified than others. Participants appeared to master some strategies, but required more practice with others. The strategies were connected to correct answers on the tests.

CHAPTER V

DISCUSSION

It was demonstrated that teaching strategies did positively affect math achievement for adolescents and problem-solving did improve. Teaching math strategies appeared to increase correct strategy identification and increased accuracy on achievement tests. Participants employed more correct strategies for the post-test than for the pre-test. Additionally, all participants received higher scores on the post-test than on the pre-test.

Validity

This study used a small sample of students attending an alternative school. The already small sample size was further decreased during the study due to expulsions of two participants before the post-test. The study focused on math strategies only, so potential for implications in other subjects was not determined. Additionally, the time frame of the study was short. The intervention only lasted for two weeks, and only during one unit. More time for the intervention might have changed the scores further, allowing the participants more time to learn the strategies. The pre-test and post-test were very close together, which can affect the results as well. Also, additional follow-up was needed to see if the results of the intervention would be maintained in subsequent tests.

Connections to Previous Studies

Other studies do recommend teaching strategies to students to improve test anxiety and achievement. In general, this study supported the results of previous studies. For example, in the Carter et al. study, the researchers recommended strategy instruction connected to specific problems (2006). They said that students should learn strategies in each lesson for each problem. During the intervention period of this study, participants were instructed daily in strategies for

problems learned in each lesson.

In Birenbaum's study (2007), some students performed poorly because they knew they did not know the material, so they did not expect to perform well. On the pre-test, one participant refused to fill in the strategy sheet because he said he had no idea, so why bother trying. On the post-test, after the intervention, he took the strategy sheet and the test more seriously.

Participants felt similarly on the pre-test, but even after no instruction on the math content, they felt more able to complete the post-test.

The strategy sheet was used during the tests and during the intervention. In many ways, it acted like a crib sheet for the participants so that they could remember the kinds of strategies. Erbe's study (2007) suggested that crib sheets reduce anxiety and can improve learning. Participants in this study felt uneasy without the strategy sheets, and they used them during class assignments as well as the tests.

Implications

Future research could expand on the results in this study in many ways, including increasing sample size, time, and frequency. The population was specialized and small, so future studies should go to regular schools and use larger populations. With more time, studies could last over an entire school year. Strategies could be tested on multiple assessments throughout the year, allowing researchers to see if the strategies truly work with all math topics, and not just isolated areas.

After more research has been conducted, studies could focus on specific strategies, even applying them to other subjects. For example, tables, pictures, and lists work for a variety of subjects, and researchers could try an intervention that focused on one or two strategies for an entire school, and not just for math classes. Finally, more research should be done to connect

strategies to test anxiety. It was observed by the researcher that participants felt more comfortable on the post-test than on the pre-test, but more research is needed in this area. Surveys could be used to analyze participants' anxiety levels before and after the strategy instruction.

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