THE EFFECT OF STRUCTURED WRITING ACTIVITIES UPON STUDENT ACHIEVEMENT IN MIDDLE SCHOOL MATHEMATICS

by

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ABSTRACT

THE EFFECTS OF STRUCTURED WRITING ACTIVITIES UPON STUDENT ACHIEVEMENT IN MIDDLE SCHOOL MATHEMATICS

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With the new Texas Assessment of Knowledge and Skills (TAKS) test, teachers are pressured to get their students to not only pass the test but to excel. The purpose of this study was to determine the effects of structured writing activities upon student achievement in middle school mathematics classes. Results from the TAKS scores of two groups of eighth grade Pre-Algebra students were analyzed to determine if the addition of structured writing activities within the mathematics curriculum increased student mathematical achievement. An independent groups t-test was utilized to determine if any significant differences between the groups existed for writing verses non-writing, time of day, and gender. Findings indicated that there was no significant difference between the experimental and control group, afternoon and morning classes, nor male and female students in terms of mathematical achievement on the TAKS test.

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Chapter 1

Introduction

Background

With the new Texas Assessment of Knowledge and Skills (TAKS) test, teachers are pressured to get their students to not only pass the test but to excel. The TAKS's "Golden Performance Acknowledgement (GPA) system acknowledges districts and campuses for high performance" (TAKS, 2004b). The schools are rewarded based on the number of students that get commended on their TAKS test scores. The mathematics portion of the test has many problems that require reading and deciding what to do even before performing any mathematical operations. In order for students to succeed on this test, they need to not only know the mathematical concepts that are expected at their grade level according to the Texas Essential Knowledge and Skills (TEKS) but also to be able to read at a level to understand the context of the problem enough to be able to apply the correct mathematical concept. Writing in the mathematics class can help the students understand the concepts better. The National Council of Teachers of Mathematics [NCTM] (2000) agrees with this by saying, "In classrooms where students are challenged to think and reason about mathematics, communication is an essential feature as students express the results of their thinking orally and in writing."

Rationale for the Study

The main purpose of this study was to explore the use of writing instruction in a mathematics classroom in terms of its impact upon student achievement. "Writing encourages students to examine their ideas and reflect on what they have learned. It helps them deepen and extend their understanding. When students write about mathematics, they are actively involved in thinking and learning about mathematics" (Burns, 1995, p. 13). Usually if someone can put something in his/her own words, not just memorize a definition, then he/she will have thought about the concept enough to truly understand it. Teachers know their students need to understand the concept enough to know when to use it and to be able to apply the new knowledge to real life.

NCTM (2000) further supports the need to develop deeper understanding by discussing how many students think all mathematics problems can be solved right away with little thought. If they cannot immediately solve a problem they will give up, which makes them view themselves as inept problem solvers. Students also believe there is only one way to solve a mathematics problem, so they never learn how exciting it is to find several ways to solve a problem. To help students break these confines, teachers need to show students how to think about and examine the problems before trying to solve them. They can do this by showing students that when they write, they are actually discovering how they think about mathematical ideas. This procedure can also make them curious about the unique ways their classmates think about mathematics (Baxter, Woodward, Olson, and Robyns, 2002). Students need to understand the teacher's way is not the only way to solve a problem. Goldsby, and Cozza (2002) also realized not all students view problems the same way and having students share their reasoning allows other students to see there are many ways to solve the same problem. The authors also saw students were more likely to remember how to solve a problem once they figured it out on their own because it became more meaningful to them and made sense to them. Also, when students experience success in solving a problem using their own thought process, their self-esteem grows (Baxter, et. al., 2002).

Importance of the Study

This study explored the idea that "writing not only benefits children by contributing to their learning, it benefits teachers by helping them assess what their students are learning" (Burns, 1995, p. 29). The teacher in Goldsby's and Cozza's (2002) study said she would read her students' journals and adjust her instruction according to what they said. When the students showed her they knew more or less than she expected, she changed her lesson for the next day to adapt to their needs.

The study also helps schools by exploring the impact of structured writing activities upon student mathematical achievement. Writing can personalize the learning environment, which leads to a more comfortable and productive learning environment (Goldsby, and Cozza, 2002).

The secondary purposes of this study, while incorporating writing into the regular mathematics classroom, were to explore if the time of day the instruction occurs or the student gender has an effect on the increase of student achievement with mathematical concepts. It was hypothesized the afternoon classes will show increased mathematical achievement more than the morning classes because, as Callan (1998), pointed out, students are more efficient learners between 11 a.m. and 4 p.m. It was also hypothesized males will show increased mathematical achievement more than females since, "…boys have traditionally been perceived as superior to girls in math" (Moses, Howe, and Niesz-Kutsch, 1997, p. 3).

Statement of the Problem

The primary goal of this study was to determine if writing in a mathematics classroom helps increase student achievement in mathematical concepts. It was expected the writing group would increase more than the control group. The students' achievement was measured by their TAKS (TAKS, 2004a) test scores taken in April of the students' seventh grade year and again in their eighth grade year. Each year the test was comprised of mathematical questions corresponding to the students' current grade level. The eighth grade scores were compared to the students' seventh grade TAKS scores to determine which group had a greater increase. Thus, the null hypothesis states there would be no significant differences in TAKS mathematics scores between groups of students receiving writing instruction and groups of students not receiving writing instruction.

Besides collecting data from the control group and writing group to explore increases in student achievement on TAKS mathematics tests, the test results from both groups were analyzed according to the time of day the instruction occurred. Each of the control group and writing group had morning classes and afternoon classes to see if the time the instruction occurs had an affect on learning. This null hypothesis states there would be no significant differences in TAKS mathematics scores between groups of students receiving mathematics instruction in the afternoon and groups of students receiving mathematics instruction in the morning.

Another variable that was taken into consideration was gender. The TAKS scores for both groups were compared to see if the control or writing group treatment affects one gender more than the other. The null hypothesis states there would be no significant differences in TAKS mathematics scores between students who are male and students who are female.

Research Question One

Is there a significant difference in TAKS mathematics scores between groups of students receiving writing instruction and groups of students not receiving writing instruction?

Null Hypothesis One

There would be no significant difference in TAKS mathematics scores between groups of students receiving writing instruction and groups of students not receiving writing instruction.

Research Question Two

Is there a significant difference in TAKS mathematics scores between groups of students receiving mathematics instruction in the afternoon and groups of students receiving mathematics instruction in the morning?

Null Hypothesis Two

There would be no significant difference in TAKS mathematics scores between groups of students receiving mathematics instruction in the afternoon and groups of students receiving mathematics instruction in the morning.

Research Question Three

Is there a significant difference in TAKS mathematics scores between students who are male and students who are female?

Null Hypothesis Three

There would be no significant difference in TAKS mathematics scores between students who are male and students who are female.

Operational Definitions

1. *Writing Group:* This group had regular mathematics instruction plus writing assignments to deepen their understanding and was taught by teacher A.
2. *Control Group:* This group had regular mathematics instruction without any writing assignments added into the curriculum and was taught by teacher B.
3. *Time of day instruction occurs:* Each group (writing and control) had two morning classes, which means before lunch, and two afternoon classes, which means after lunch.
4. *Student Gender:* The students marked their TAKS test with male or female.

Assumptions

Teacher A, who is also the researcher of this study, taught the students who were exposed to writing instruction. Teacher B taught students who were the control group and did not receive writing instruction. Generally, both teachers used the same lesson plans, notes, books, and assignments everyday. One of the potential limitations of the study could be teacher difference in terms of teaching styles, experience, and knowledge that may have affected the outcome of the research. To minimize teacher bias, both teachers wrote in a journal after each class. The contents of the journal included the mathematics curriculum that was taught and the implementation strategies of the instruction. Journals of both teachers were compared for consistency across the two classrooms. The previous

TAKS scores of the two teachers' classes will also be compared to ascertain if there are any differences at the beginning of the study. See tables 1 and 2 on page 25.

Organization of the Study

In this study, chapter one discusses the background, the rationale of the study, the significance of the problem, the importance of the study, the statement of the problem, the operational definition of terms, the assumptions, and the limitations of the study. Chapter two includes the review of literature as it pertains to writing within the curriculum, writing within the mathematics curriculum, impact of time of day upon student learning, and impact of gender upon student learning. In chapter three the methodology is discussed. Chapter four explains the results of the data analysis. Chapter five summarizes the findings and generates a discussion about these findings.

Chapter 2

Review of Literature

Introduction

This section reviews the literature that pertains both to writing as a curriculum tool and also to writing within the mathematics curriculum. There are many sources that support the use of writing in subject areas, such as mathematics, to improve student achievement. Literature on time of day and gender is also discussed.

Impact of writing within a curriculum

Writing has traditionally been a subject taught in English composition classes. It seems teachers of other subjects prefer not to use writing but instead choose other instructional techniques, which can easily be measured by tests that do not require extended written answers. In response to this problem, the educational movement toward "writing across the curriculum" began to grow. The theory linking writing to learning "…argues that writing is ideally suited for the discovery, formulation, and expression of ideas, particularly in personal and exploratory modes rather than merely mechanical or communicative ones" (Anson, 1988, p. 19). "Educators and curriculum developers need to come to terms with the fact that literacy and numeracy are inextricably connected and explore ways in which the development of people's literacy skills" (Gal, 1999, p. 230). A sample writing assignment that incorporates typical mathematics questions and writing can be found in Appendix B. Burns (1995) agrees that writing should not be seen as a language arts topic, but should be used in all content areas to help student think about ideas. Anson (1988) takes this idea further by saying:

> Academic disciplines, whose instructional goals are to teach students a body of knowledge while also helping them to acquire the thinking processes of professionals in the field, would seem suited to an emphasis on writing as a mode of learning. (p.19)

Impact of writing within a mathematics curriculum

Azzolino (1990) finds writing to be more than a way to communicate with others; it also can be used to clarify and refine a person's thoughts. Writing has many other benefits for students and teachers. According to Azzolino:

> Writing can demand participation of the student; help the student to summarize, relate, and associate ideas; provide an opportunity for a student to define, discuss, or describe an idea or concept; permit the student to experiment with, create, or discover mathematics independently; encourage the personalization, assimilation, and accommodation of the mathematics being taught; assist the student in reviewing, refocusing, and reconsidering topics either recently studied or considered long ago; assist in recording and retaining mathematical procedures, algorithms, and concepts for future use; assist in the translating or decoding of mathematical notation; assist in symbolizing or coding with proper notation; help the teacher diagnose a student's misconceptions and problems; provide an appropriate vehicle for the student to express and focus on negative feelings and

> frustrations as well as to emote and rejoice in the beauty of mathematics; assist in the reading, summarizing, or evaluating of texts; improve your teaching; and collect evidence for research. (p. 92)

Writing across the curriculum probably improves a student's writing, but more importantly it improves students' learning. Informal classroom writing can, "retain natural curiosity; promote confidence in reason's ability to construct order by trial and error, even in problematic circumstances; and overcome the anxiety that occurs when education stresses answers, not options, and product, not process" (Connolly, 1989, p. 6). Emig (1977) adds, "Writing is uniquely integrative, functioning as an important mode of learning involving hand, eye, and brain. In addition, writing requires a deliberate structure of meaning and provides a unique form of reinforcement and feedback" (p. 215). Other benefits of writing pointed out by Rose (1989) are:

> Writing in the mathematics classroom allows students to proceed at their own rate, using their own experiences and language; increase writing fluency; combat passivity; facilitates personal engagement in learning; provides the teacher with a unique diagnostic tool; keeps a record of students' individual travel through their mathematical experiences; and promotes a caring and cooperative atmosphere through writing interaction. (p. 27)

Students may not respond to writing very quickly since traditional thinking about mathematics by children is the quick right answer is more important than the thinking that led to the answer, which tends to make them calculate the answer without understanding (Burns, 1995). Rose (1989) sees this problem also when her, "…students try to slide through courses by externally manipulating symbols without constructing meaning of their own" (p. 15). Burns (1995), Sherin, Mendez, and Louis (2000) and Yakel and Cobb (1996) agree that in order to help students really understand what they are doing when solving problems, the students need to explain their reasoning by including mathematical arguments along with giving the answer. When presenting a new type of problem, Shutler helps students focus on understanding by emphasizing how they are going to solve the problem rather than the solution itself (Moore, Bridgman, Shutler, & Cohn, 1993). Goldsby, and Cozza (2002) take this idea a step further by pointing out a student may have a correct answer, but not really understand the process of solving the problem. The teacher assumes they understand the process, but the student may have stumbled onto the correct answer using an incorrect process. If the teacher requires the students to write the process of solving the problem down, then the students' level of conceptual understanding will be revealed. (See student example in Appendix D)

Talking about the concepts before the actual writing can also add to the understanding of the topic. "In classrooms where students are challenged to think and reason about mathematics, communication is an essential feature as students express the results of their thinking orally and in writing" (NCTM, 2000, p. 268). "The more students talk about mathematics, the more students learn about mathematics.... by exploring one's ideas, evaluating other students' methods, and posing questions for the class to explore, students can develop deep understandings of mathematics" (Sherin, et al., 2000, p. 188). Whitin and Whitin (2000) agree with the need for communication. They decided the important principles of learning are "...children are constructors of their own mathematical knowledge, learning is a social process, and writing and talking are tools for reflecting thought as well as generating new thoughts" (p. 213). Talking and writing are the two best ways for students to develop a personal voice in mathematics. Writing can be a great way to involve everyone especially if students get to write their ideas to an open-ended question or statement (Whitin & Whitin, 2000). One principle to keep in mind is teachers need to include writing daily, not just sporadically throughout the year (Whitin & Whitin, 2000). National Council of Teachers of Mathematics (2000) believes that:

> teachers can use oral and written communication in mathematics to give students opportunities to—think through problems; formulate explanations; try out new vocabulary or notation; experiment with forms of argumentation; justify conjectures; critique justifications; and reflect on their own understanding and on the ideas of others. (p. 272)

There is almost always more than one way to arrive at a particular answer and occasionally more than one acceptable solution. Shutler has found "…children's understanding of math process and concepts is enhanced through the verbalization of their thoughts. In addition, talking through a problem and making sure that everyone understands can improve basic verbal skills" (Moore, et. al., 1993, p. 32). Bridgman (Moore, et. al., 1993) has found that students love to talk, but more importantly they need to be allowed to use language to make sense of their world. Using oral language helps children internalize their understandings.

"Writing can assist math instruction… by helping children make sense of mathematics and by helping teachers understand what children are learning" (Burns, 1995, p. 3). Azzolino (1990) and Burns (1995) agree when using writing in the classroom as a teaching tool, the teacher should not dwell on spelling, punctuation, or grammar, but rather focus on the content of the paper. Giving the student feedback on the content of their writing is important for learning. Sometimes asking the student to verbally explain what they were thinking also helps the student make a connection to the lesson and also helps the teacher see what they really understand (Burns, 1995). It is important students understand why they are writing. Students should be reminded their writing is important to the teacher, since he or she will use it to plan future lessons. Burns (1995) tells them, "My job is to help you understand math. To do my job, I need to know what you do understand and what you don't understand" (p. 128).

Ways to incorporate writing into mathematics

There are many different methods for incorporating writing into the mathematics classroom. Four ways used by Moore, et. al. (1993) for integrating various areas of the language arts into the mathematical curriculum are:

> creating stories by transferring real-life math situations into oral, pictorial, and written accounts; using children's literature as a venue for developing math concepts; developing oral articulation through group problem solving; and developing writing skills and math concepts through the use of math journals. (p. 27)

A good way to start a new year could be to give the students a journal for writing how they feel about mathematics. Beside journal writing, Burns (1995) suggests having students write about their most and least favorite activities, how they worked with their partner, a letter, or reflect on what they have learned can be a useful insight to how students respond to their learning experiences. Moore (Moore, et. al., 1993) uses journal writing in her mathematics classroom almost on a daily basis. She sees it as an effective way to find out what children understand about the concept as well as a strategy for furthering their understanding. Journals also help the teacher evaluate each child and see the impact of a certain mathematics activity. Along with journal writing, other personal interactions between the teacher and student can help the student refine their thinking and have a better understanding. Another benefit to journal writing is it gives children a chance to use their imagination and creative writing skills. (See student example in Appendix F). Not only do the journals let the teacher see what the students understand, they also show the teacher what the student is having trouble with so she or he can plan the next lesson to address the weakness. (See student example in Appendix A). Journal writing can be a nice change of pace in a mathematics class and can be very interesting to see how children process mathematical concepts (Moore, et. al., 1993). Burns (1995) adds keeping journals can be a good way for students to have an ongoing record about what they are doing and learning in their mathematics class. Some other benefits, pointed out by Rose (1989) are:

> when students are stuck on a problem and write out their thought process, they see their errors and often solve the problem; journal writing slows the thinking process, which gives students a chance to arrive at their own solutions as well as to understand their thought processes; teachers benefit as they receive feedback on lessons and become aware of when students are reached by certain activities; students make notes, not take notes, and produce interpretive comments and personal reminders; as the teacher writes back to the students, students realize the teacher hears and cares; and students gain the opportunity to formulate, organize,

> internalize, and evaluate concepts; answer self-generated questions; and generate a record of their thinking. (p. 26-27)

Journal writing should focus on the meaning of the words rather than the grammatical correctness. Journal writing helps the students by requiring them to be involved in connecting the new and old information. Students also feel more comfortable confessing they do not understand a topic in a note to the teacher rather than making a statement in front of the class. Writing to the teacher establishes a unique relationship between the student and teacher (Rose, 1989).

Another important writing assignment is summarizing. When students are asked to summarize what has been discussed in class, it can be habit forming by encouraging students to review what has come before (Azzolino, 1990). This type of writing can also help students be able to express their mathematical understanding. Summaries make the information more personal and help the student retain the concepts. When a student has to write a mathematical explanation, they are moved towards understanding. Using their own words to write out definitions requires students to think about the meaning of the concept and they usually remember it better. (See student example in Appendix C).

Giving a creative writing assignment occasionally can help change up the pace of doing the same thing everyday. It also can catch the attention of the students who may not be interested in mathematics but are confident in their writing abilities. "An assignment like this can help students broaden their view of mathematics" (Burns, 1995, p. 103). Students also enjoy and feel comfortable with letter writing, and they prefer to have an audience for their writing (Rose, 1989).

Writing can be used in place of a test. Having a student explain the process of solving a problem can show the teacher very clearly if they understand the process. Goldsby, and Cozza (2002) note some students simply do not test well. Those students need a chance to prove they understand the process; having them explain it in writing gives them that chance. (See student example in Appendix E).

The literature shows writing can be a very effective tool in the mathematics classroom. Students need to learn to use a variety of strategies to solve problems, and "Writing requires students to formulate and clarify their ideas and, therefore, can contribute to helping students develop these abilities" (Burns, 1995, p. 69). Teachers do need to remember "Writing is not the end but means for teaching mathematics" (Azzolino, 1990, p. 93).

Impact of time of day upon student achievement

The time of day students receive instruction can also greatly affect the amount of learning that occurs in a class. If a student is too sleepy or too exhausted, then he/she will not be able to concentrate well enough to learn everything being taught. Callan (1998) discussed how someone's body temperature is related to their efficiency. He said on average, the human body temperature ranges from a little above 97 degrees Fahrenheit to nearly 99 degrees during a day. When a body temperature is low, so is the efficiency of that person. Usually, body temperature is lowest around 5 a.m. Many students' temperature, and efficiency, stays fairly low in the morning. Normally students are approaching their highest efficiency and understanding around 11 a.m. This level lasts until around 4 p.m. when it begins to decline. Of course, these factors portray the average student; some students are at their peak efficiency in the morning, but not the majority.

Dunne, Roche, and Hartley's (1990) study on memory seems to also say that students will remember information better in the afternoon as opposed to the morning hours. The researchers did find short term or immediate recall was better in the morning, but in mathematics, it is important for students to remember information over long periods of time. Long term or delayed recall was found to be greater in the evening, which is logical since one's ability to organize material to be remembered improves during the course of a day (Dunne, et. al., 1990). Since Dunne, et. al.'s (1990) study shows the ability to process the meaning of information improves during the day and Callan's (1998) findings point to the fact students are more alert later in the day, it is expected students do better in classes that take place later in the day.

Impact of gender upon student learning

A student's gender may affect how well the student performs in school. For decades, the traditional belief was girls are good at English and boys are good at mathematics. Society teaches children they have certain roles they are expected to fit into. These expectations tell girls they are not going to be good at mathematics, so they should not even try. Moses, et. al. (1997) found that by the age of six years old, children already connect certain careers with gender. These subtle stereotypes contribute to these children's career choices, and therefore to their course choices as they pursue a high school and/or college degree.

Forgasz, Leder, and Garnder (1999) used the Fennema-Sherman Mathematics Attitude Scale (MAS) to determine if the stereotyping of mathematics was still a male domain. In the 1970's, when the MAS was first used, it was found that mathematics was viewed as a male domain. In the 1999 study, it was found the stereotyping of mathematics is no longer exclusively a male domain. Some people now actually believe it is a female domain. After the study, Forgasz, et. al. (1999) conclude that, "Mathematics as a male domain remains a relevant variable in explanations for persistent patterns of gender difference in some mathematics learning outcomes" (p. 347).

A student's mathematics-related belief system can also determine how much that student will achieve in mathematics. De Corte and Op't Eynde (2003) studied students to see how their belief systems, gender, and mathematics achievement were related. The classes they used for their study were homogeneous groups of low (vocational), moderate (humanities), and high (classical) intellectual levels. For the classical and vocational tracks, girls were more likely to have positive beliefs than boys. In the humanities track, however, boys valued mathematics more and were more confident. So boys were more confident and had the more value in mathematics only for the moderate achievers, which is not what was expected. There has been a shift is the last few decades from boys dominating mathematics to girls catching up with or maybe even passing boys in their performance of mathematics.

Traditionally, males were seen as naturally more gifted in mathematics than females, but now most researchers have realized the males were falsely stereotyped into the role of being the better mathematicians (Moses, et. al., 1997). Most researchers now believe males and females are equal in their abilities of mathematics. If so, then why are there still more males taking advanced mathematics courses and, therefore, more males working in the mathematical fields? Moses, et. al., (1997) took a survey to see how many girls and boys are taking advanced mathematics courses. The study found, beginning in late junior high school, the number of female students in proportion to males taking advanced mathematics progressively shrank during high school and even into college. Many reasons why girls were underrepresented were suggested. The first was female students may receive fewer mathematics-related opportunities. Another reason was the possibility of less teacher encouragement in mathematics. They also found some counselors were discouraging women from taking mathematics courses. Even parents appeared to have higher expectations for their sons in mathematics. There are few female role models for females in advanced classes, since men usually teach those. Another reason that plays a major role is choice; many students simply choose not to take any more mathematics beyond the minimum. In Moses, et. al.'s (1997) survey, it was found females tend to have higher educational goals than males, even though males still accomplish more mathematically. One positive finding was that males were the majority in mathematics only in the very highest level courses, not across the board in all mathematics courses.

Summary

In this section, the literature concerning writing was reviewed. The use of writing in the mathematics classroom was the main focus. The impact writing has within the curriculum was discussed. Many types of writing and ways to implement the writing in a mathematics classroom were also presented. Literature as it applies to time of day and gender was also examined.

Chapter 3

Methodology

Introduction

In this section, the procedures of the study are described. The description of the population and the sample are discussed. Data collection and analysis are also explained.

Description of the Population and the Sample

The subjects used in this study were eighth grade students from a junior high school in the southeastern part of Texas. This school's population has about 81% White students, about 15% Hispanic students, only about 1% Asian students and about 1% African American students. The two teacher's classes are convenience samples with pre-constructed groups. All classes were taught pre-algebra, which is regular eighth grade mathematics, but the only TAKS scores used in this study were from the students who signed the consent form. Students who did not sign received instruction but their scores were not included in data collection or analysis. Each class had between 15-30 students. Teacher A had 27 students in her first class, 24 students in her second class, 22 students in her third class, and 21 students in her fourth class. Teacher B had 25 students in her first class, 30 students in her second class, 15 students in her third class, and 17 students in her fourth class. The classes varied in size due to the scheduling conflict with elective and physical education classes since they were only offered during certain periods. Teacher A, who is also the researcher of this study, had the students exposed to writing instruction. Teacher B had the students that comprised the control group and did not receive writing instruction.

Data Collection

All classes were taught the same mathematical concepts, and used the same curriculum, standards, and schedule. The school year started with all classes using the same assignments and projects. After a few weeks of school, the writing classes started doing some writing assignments. During this time all classes received the same mathematical instruction from their teacher, but the control group was not given writing assignments. Since teacher A spent class time to write, teacher B had more time in her class to do more practice problems with her class. This procedure continued through the end of the school year. In the middle of the spring semester, the students took the mathematics TAKS test.

The writing assignments varied. Journal writing was the primary tool. Students wrote in their journals about what they had learned, what they do not understand, or were given a topic. Writing out step-by-step procedures or explanations on select homework problems, tests, and quizzes were also used quite often. Group work led to writing about observations. Other papers also were assigned, but most writing was done in class.

The writing group was given some extra instruction on what was expected when they wrote and provided guidelines on how to write. The control group did not discuss writing as it applied to mathematics. Both groups received the same mathematics lessons.

The instructional time for each group was every school day for a block period, which was about one hour and 20 minutes.

Instrumentation and Design

Each TAKS test contained 50 to 60 multiple-choice questions to test the students' knowledge and understanding of the required mathematical concepts for their grade level. The test was composed of questions that were developed by the State of Texas. The test is valid since the questions came from the objectives the students should have mastered during the school year. The students had one day to complete the mathematics TAKS test.

Statistical Analysis

The purpose of this study was to explore the impact of writing on student achievement in a mathematical classroom. The null hypothesis states that there would be no significant difference in TAKS mathematics scores between groups of students receiving writing instruction and groups of students not receiving writing instruction. A secondary hypothesis was to determine if there was a significant difference in TAKS mathematics scores between groups of students receiving mathematics instruction in the afternoon and groups of students receiving mathematics instruction in the morning. The other secondary hypothesis was to determine if there was a significant difference in TAKS mathematics scores between students who are male and students who are female. In order to test these null hypotheses, the independent-measures t-test was used on the TAKS mathematics scores. Means were computed for the TAKS scores and were tested to determine significance between the experimental and control groups. The same procedures and analysis were used to determine significance based on time of instruction and student gender.

Summary

This section provided information on the methodological design of the study. The description of the population and the sample was discussed. The data collection and analysis were explained.

Chapter 4

Results

Introduction

This section presents the results of the study. Besides the writing and control groups' scores being compared, all morning and afternoon scores were compared to determine if time of day effected student achievement. All males and females were also compared to determine if gender effected student achievement.

Research Question One

Is there a significant difference in TAKS mathematics scores between groups of students receiving writing instruction and groups of students not receiving writing instruction?

Since the two groups were significantly different to start the year with ($p = 0.036$), gain scores must be used to compare the two groups. See tables 1 and 2. Data were analyzed by comparing the experimental and control groups' difference scores. The difference scores were found from the students' seventh and eighth grade TAKS scores to determine the groups' increased achievement. An independent-samples *t* test was conducted to evaluate the hypothesis that student achievement increases when writing is implemented in the mathematics classroom along with regular instruction as opposed to

Table 1

t-Test

Group Statistics

	Which teacher?	N	Mean	Std. Deviation	Std. Error Mean
TAKS 7	A	75	31.85	7.074	0.817
	B	39	34.74	6.548	1.049

Table 2

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95 % Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
TAKS 7	Equal variances assumed	0.329	0.568	-2.122	112	0.036	-2.890	1.362	-5.589	-0.191

only using regular mathematics instruction without any writing. The test was not significant, $t(112) = 0.206$. $p = 0.837$.Students in the writing group ($M = 2.9867$, $SD = 5.07110$) on average achieved about the same as those in the control group ($M = 2.7949$, $SD = 3.93486$). The 95% confidence interval for the difference in means was 3.68973, ranging from -1.65307 to 2.03666. See tables 3 and 4.

Research Question Two

Is there a significant difference in TAKS mathematics scores between groups of students receiving mathematics instruction in the afternoon and groups of students receiving mathematics instruction in the morning?

Data were analyzed by comparing the afternoon classes' and morning classes' difference scores. An independent-samples *t* test was conducted to evaluate the hypothesis that afternoon classes will achieve higher scores in the mathematics classroom than morning classes. The test was not significant, $t(112) = 0.591$. $p = 0.556$. Students in the afternoon classes ($M = 3.2558$, $SD = 3.81159$) on average achieved about the same as those in the morning classes ($M = 2.7183$, $SD = 5.17462$). The 95% confidence interval for the difference in means was 3.60661, ranging from -1.26580 to 2.34081. See tables 5 and 6.

Research Question Three

Is there a significant difference in TAKS mathematics scores between students who are male and students who are female?

Data were analyzed by comparing the males' and females' difference scores. An independent-samples *t* test was conducted to evaluate the hypothesis that males will achieve higher scores in the mathematics classroom than females. The test was not

Table 3
t-Test
Group Statistics

	Which teacher?	N	Mean	Std. Deviation	Std. Error Mean
Difference Score	A	75	2.9867	5.07110	0.586
	B	39	2.7949	3.93486	0.63

Table 4
Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95 % Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Difference Score	Equal variances assumed	2.038	0.156	0.206	112	0.837	0.19179	0.93110	-1.65307	2.03666

Table 5
t-Test
Group Statistics

	Time	N	Mean	Std. Deviation	Std. Error Mean
Difference Score	PM	43	3.2558	3.81159	0.581
	AM	71	2.7183	5.17462	0.614

Table 6
Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95 % Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Difference Score	Equal variances assumed	3.905	0.051	0.591	112	0.556	0.53750	0.91013	-1.26580	2.34081

significant, $t(112) = 0.718$. $p = 0.474$. Male students ($M = 3.2857$, $SD = 5.15186$) on average achieved about the same as female students ($M = 2.6462$, $SD = 4.34249$). The 95% confidence interval for the difference in means was 3.52846, ranging from -1.12467 to 2.40379. See tables 7 and 8.

Summary

In this chapter, the statistical analysis of the data was presented. No significant differences ($p < .05$) were found in any of the three stated hypotheses. There is no statistically significant difference ($p < .05$) between student achievement in terms of the seventh and eighth grade TAKS scores between the control and the writing group, the morning group and the afternoon group, or the male group and the female group.

Table 7
t-Test
Group Statistics

	Gender	N	Mean	Std. Deviation	Std. Error Mean
Difference Score	M	49	3.2857	5.15186	0.736
Score	F	65	2.6462	4.34249	0.539

Table 8
Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95 % Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Difference Score	Equal variances assumed	2.457	0.120	0.718	112	0.474	0.63956	0.89041	-1.12467	2.40379

Chapter 5

Discussion

The results do not support the hypotheses. According to Table 1 at the beginning of the study the difference between the two scores were statistically significantly different (P = 0.036). Therefore the decision will be centered on data analysis for gain scores. It is known that students performed many writing assignments that required them to write out the steps of problems or explain why something works the way it does. This required the students to analyze the information thoroughly to be able to answer the question. Examples of typical writing assignments can be found in Appendix A-F.

The results may be more obvious if the experimental group had used writing more often or over the course of several years. Since students are not used to writing in other classes besides language arts, it takes them awhile to warm up to the idea. So, the beginning of the year was spent convincing them it is alright to use writing in the mathematics classroom. It was also observed that students resist greatly when asked to write. Little effort is put forth from many students even when the students understand there is no right answer.

Other researchers, such as Burns (1995) and Moore, et. al. (1993), have found writing to be beneficial with students. Even though this study could not prove writing increases student achievement, their research suggests that teachers should still consider using writing in their classrooms because it has shown in the past to help students.

The time of day data also were not significant enough to prove the afternoon is better than the morning. The mean was slightly higher in the afternoon. One factor that might have affected that outcome is the students' previous classes. The research did say students typically do better in the afternoon, but there are exceptions to the rule, a student can be a morning person (Callan, 1998).

The gender research shows females start out in school more advanced in mathematics, then around junior high the males and females are about the same, and throughout high school and college the males advance beyond the females (Moses, et. al., 1997). Since the subjects in this study are in junior high, according to Moses, et. al.'s (1997) research, there should be no significant difference between the groups. If this study had been conducted in an elementary or high school, it is possible a greater difference would be found.

Limitations

There were several limitations in this study. The main limitation was not all the students in the control group were included in the study because permission to use their scores was not obtained, so there were fewer students included in the control group than the writing group. The teacher differences in terms of teaching styles, experience, and knowledge may have also affected the outcome of the research. Due to administrative placement of students, the group that received writing in the curriculum had a larger population of special needs students and economically disadvantaged students.

Further Research

An extension of this research project could be to conduct the experiment over a longer time interval. Checking to see the groups are similar at the initial part of the study would produce results that would be more valid and reliable.

To obtain a greater idea of how time of day effects instruction, students could be studied over several years if they are placed in only the morning or only the afternoon every year. Because if the student in years past has always gone to mathematics class in the morning, but now has mathematics in the afternoon this year, then that student may have already developed bad habits in mathematics since it had always been taught during a time of low efficiency. Or just the opposite, where the student has always gone to mathematics class in the afternoon, so that student has a good foundation that will help him/her if he/she gets placed in a morning mathematics class.

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Appendix: Student Work Sample A

Warm-up

1. What mathematics topics (that we learned this year) are you still not comfortable with?

I'm not comfortable with surface area and some volume stuff

2. What mathematics topics (that we learned this year) do you not have any trouble with?

pythagorean theorem
area + perimeter
circumference

3. How do you feel about the TAKS tests coming up next week? (Are you confident, nervous, etc.) And why do you feel this way?

Confident because the test seems to be easier then the stuff we do in class.

4. **What are you planning on doing to prepare for TAKS?**

Eating a good breakfast, buying new erasers, studying, + getting a lot of rest

5. **Do you think it is import to test kids over what they have learned all year? Why or why not?**

Yes and no. The tests are good to see whether what you teach is sinking in and to tell you if you're ready to move to the next grade level that is full of new + quite possibly harder material.
No because tests sometimes stress out the students and they dont do as well as they should

6. **If you were able to make your own test instead of TAKS, what would your test be like?**

About the same except I'd give the option of taking it online or in pencil, because peoples choices might vary.

Appendix: Student Work Sample B

Graphs

✓ 1. What number do you times the decimal by to get the degrees for a circle graph? 300

✓ Why do you times by that number? because that's how many deg. are in a circle

/✓ 2. Name the two biggest differences between a bar graph and a histogram (make sure you specify which one you are referring to): histogram - bars touch, bargraph they donot. histogram - intervals, bar graph - no intervals

✓✓ 3. Name as many things as you can that are the same in a bar graph and a histogram: Title, numbers, both have bars, measure

4. Match the information with the most appropriate graph/chart:

✓ E 1. Use this if you wanted to show the different heights in a class and show which are boys and which are girls	a. Bar Graph
✓ C 2. Use this to tally favorite candy	b. Circle Graph
✓ D 3. Use this to show height with intervals	c. Frequency Table
✓ A 4. Use this to show how many students made an A, A-, B+, etc.	d. Histogram
✓ B 5. Use this to show what percent of your budget is spent on each category	e. Line Plot

✓ 5. When making a circle graph, what should your total add up to on the ratios and decimals? 1

✓ 6. When making a circle graph, what should your total add up to on the percents? 100%

Appendix: Student Work Sample C

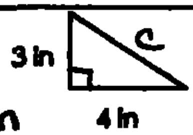
Pythagorean Theorem

What is the Pythagorean theorem? In a right triangle, the square of the length of the hypotenuse is equal to sum of the squares of the lengths of the legs. $c^2 = b^2 + a^2$

Given a right triangle, which side is always the "c"? The "c" is a always the longest side and is also called the hypotenuse.

What are the other two sides of the triangle called (a & b)? a & b is called the legs.

EXPLAIN how to solve for the hypotenuse on:



First you write $a^2+b^2=c^2$, then you plug in the numbers that you know so it is $3^2+4^2=c^2$. the 3 and 4 is the legs so they can either be a or b then the 3^2 becomes a 9 and the 4^2 becomes a 16 then you add those two numbers and you get $25=c^2$ but then the c is still square and to undo the c^2 you must get the square of both sides and then you answer is 5 in.

EXPLAIN how to solve for the missing leg on:

First you write $a^2+b^2=c^2$, then you plug in the numbers that you know and the c is always the longest side of the triangle. So the equation is now $a^2+3^2=5^2$. But the 3 can either be the a or the b it doesn't matter. The 3^2 becomes a 9 and the 5^2 becomes a 25 then you and 9 and 25 together. Then numbers are on opposites so you do the opposite operation and subtract 9 from both sides. So now you are left with $a^2=16$ but the a is not by itself so you must take the square root from both sides to cancel it out. Then it is left with $a=4in$.

What is the one different step in solving #4 and #5? In number 5 you had to subtract the numbers and in 4 you didn't have to.

7. Why do you take a square root at the end of these problems? to cancel out the square.

8. EXPLAIN what a square root means: one of the two equal factors of a number. If $a^2=b$ then a is the square root of b. A square root of 144 is 12 since $12^2=144$.

9. EXPLAIN how to square a number: put an exponent ^{2} at the top example 12^2.

10. Write your own word problem that requires you to use the Pythagorean theorem to solve: Keeree likes to run in her front yard. This time she ran across her fence 5 yds to the left and 6 yds up. But she wants to run across her yard this time. How many yards does she has to run.

11. Solve your own problem on #10:

$a^2+b^2=c^2$

$6^2+5^2=c^2$

$36+25=c^2$

$\sqrt{61}=\sqrt{c^2}$

$8=c$

8yds

Appendix: Student Work Sample D

Work	Explain
# 15 answer: C $\frac{40}{100} = \frac{32}{x}$ $\frac{40x}{40} = \frac{3200}{40}$ $x = 80$	I put the the percent over a hundred and 32 over x then I cross mulitply then I got 40x equals 3200, then I divided by 40 and I got 80.
# 22 answer: H $\frac{1}{4} \cdot \frac{2}{6} = \frac{2}{24} \div 2 = \frac{1}{12}$	There 4 colors and you can only pick one and there are 6 numbers on a die and you can pick 2. Then you [illegible] thur and 2 over 6 then [illegible] it, and you get 2 over 24 then you [illegible] simplify and get one over 12.
# 25 answer: B 210 20 70 300 $\frac{300}{400} = \frac{3}{4}$ $\frac{4}{4} - \frac{3}{4} = \frac{1}{4}$	I added up all the students that had either [illegible] scooter or skateboard and I got 300 and put it over 400 because there were 400 students and [illegible] and got 3/4 but it asked me [illegible] skateboard or scooter so I [illegible] 3/4 from 4/4.

Appendix: Student Work Sample E

Integer and Equation Quiz

Write the rules (in your own words) for the following integers:

1. **Adding integers with the same sign:** Just add the two numbers and Keep the Same Sign
2. **Adding integers with different signs:** Subtract the two numbers and Keep the sign of the bigger number,
3. **Subtracting integers:** Keep the first number the same, change to add, and change the last number, then Solve
4. **Multiplying integers:** Multiply the numbers and if its the same sign its positive, if its different its negative
5. **Dividing integers:** Divid, and Keep positive for same numbers and negative for different

Write and example and solve for each type of integer (#6-10):

6. **Adding integers with the same sign:**

   $16 + 3 = 19$

7. **Adding integers with different signs:**

   $18 + {}^{-}9 = 9$

8. **Subtracting integers:**

$-10 + (5) = -5$

$\begin{array}{r} -10 \\ 5 \\ \hline -5 \end{array}$

9. **Multiplying integers:**

$(-2)(-3)(-5)(-6) = 180$

$6 \cdot 30$

10. **Dividing integers:**

$-42 \div 6 \quad 6\overline{)-42} = -7$ (quotient -7)

11. **Explain how to solve 2x + 15 = 35 (be as detailed as possible):** subtract 15 from 15. then subtract 15 from 35 which equals 20. write 2x=20. Since your multiplying you would divide 2 by 2 wich cancels out. Then divide 20 ÷ 2 which equals 10 Then after that check your answer

great answer!

12. **Why can you mark out +15 and – 15 in the problem on #11?** Positive 15 and negative 15 both equal 0 so zero ~~does not~~ is not worth anything.

13. **Why can you mark out 2 ÷ 2 in the problem in #11?** You mark it out because 2 ÷ 2 equals one and that really won't help me. and it's easier that way.

Appendix: Student Work Sample F

"Mathmatics in Daiyly Life"

In the real world Math is used in different ways. When eating out, the waiter is tiped fifteen to twenty percent of the bill.

Math is also used for grocery shopping and everything haveing to do with money.

To build something you need measurement. Probibly all jobs in daily life has math, From Contractor and Engineer to a casheer and a cook, every job has to do with math.

Even without a job, to live, you'll need math. To Shop, cook, Count, and sell any kind of property fairly.