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A comparison of two teaching methodologies in a middle school algebra classroom

Kristina L. Tucky
Regis University

A COMPARISON OF TWO TEACHING METHODOLOGIES

IN A MIDDLE SCHOOL ALGEBRA CLASSROOM

by

Kristina L. Tucky

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ABSTRACT

A Comparison of Two Teaching Methodologies in a Middle School Algebra Classroom

This study was an attempt to determine if a change in teaching methodology would have a positive effect on the outcome, as measured by a chapter test, of an algebra class. The research involved a pretest-posttest control group design of two sections of an eighth grade algebra class. The control group received the standard instructional practice, known as the "direct method", while the treatment group received the same "direct method" and additional "constructive" methodology in the form of manipulatives and group reading of the subject matter. No statistical difference was found between the means of the two classes on the posttest, therefore, it was concluded that the additional teaching methodology did not affect the student outcome.

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Chapter 1

INTRODUCTION

National inconsistency in mathematics curriculum has been addressed in research and literature since the late 1950's. The United States Government's realization, upon the launch of Sputnik, that our country was behind in both math and science has led to an onslaught of research designed to assess the reasons for this lag, and strategies that can be used to make up the difference. While recognizing the need to approach the problem systematically and incrementally, teachers currently in the classroom need more immediate strategies to assist their students in achieving the highest level of math competency.

This chapter will include a brief background of mathematics curriculum deficiency in the United States as well as a statement of the problem to be addressed by this research. The purpose of the project along with the specific research question will be clearly addressed. This chapter will also include a brief outline of the methods to be used for the study, and any terms pertaining specifically to the study will be clearly defined.

Background of the Problem

The subject of mathematics instructional inconsistency has been analyzed and reanalyzed with the result being a tremendous number of recommendations for changes in the curriculum. Silver (1998) reported that changes in both the curricula and teacher training are necessary. There have been studies assessing what changes in curricula are needed as well as studies to determine the best methods to teach the teachers. Currently, there are pockets of change taking place throughout our country. However, overall implementation of the recommended changes will take a concerted effort on the parts of the individual school districts to establish these changes.

Statement of the Problem

It has been reported that mathematics teaching in the middle grades and beyond is mediocre at best (Silver, 1998). When compared to other countries, even top students fail to succeed at a high level. This would suggest that changes need to be made in the math curriculum and the methodology with which it is taught. While an individual teacher cannot make immediate changes to the entire math curriculum within a school or school district, he or she can make changes in the way the subject is taught within a specific class. The problem to be addressed by this research project was the continuing decline of mathematics competency in middle school students and the need for immediate interventions.

Purpose of the Project

The educational community has acknowledged that both the math curriculum and the methodology used to teach the math curriculum must change. This is not a change that will occur rapidly as it involves the different states and many school districts. In the meantime it is imperative that teachers begin to implement needed changes immediately. The purpose of this project was to determine whether a proposed change in teaching methodology will have a positive effect on a middle school algebra class as measured by student performance on an end of unit test.

Research Question

Will eighth grade algebra students who receive “constructive” as well as “direct method” instruction perform better on a unit test than their counterparts who receive only direct method instruction? For the purpose of this study, constructive instruction included the use of manipulatives, reading the chapter aloud, the taking of notes, and practice. Direct instruction was characterized primarily by taking notes related to the lecture and completing practice problems.

Proposed Methods

Two sections of an eighth grade algebra class were the source of the participants for this research project. The project design was a pretest-posttest control group design (Leedy & Ormrod, 2005). This design consisted of an experimental group and a control group which were randomly assigned to two algebra classes.

In addition to the direct instruction defined above, the members of the experimental group received instruction through the use of manipulatives and the reading of the chapter materials aloud. The experimental group continued its lessons with this combination of constructive and direct instruction. These students read the chapter aloud with their teacher and utilized any modeling lessons included in the chapter. This was followed by direct instruction and practice. The members of the control group received direct instruction, as defined above, with no additional treatment. The members of the control group continued their lessons with direct instruction, using the textbook only as a guide for lesson planning and as a source for practice.

Both groups were tested on an initial chapter (pretest) to determine a basic starting point. They were both tested at the end of the unit to assess the outcome. The time frame for completion of the chapter and testing was slightly longer for the experimental group, because the methodology was more extensive. The pretest and posttest scores for both groups were compared using statistical analysis to determine the effectiveness of the proposed treatment.

List of Definitions

Manipulative. Manipulatives are any of various objects designed to be moved or arranged by hand as a means of developing motor skills or understanding abstractions, especially in mathematics (Manipulative, 2006)

Constructive Method. Constructivism views learning as a process in which the learner actively constructs or builds new ideas or concepts based upon current and past knowledge (Constructivism, 2006).

Direct Method. The direct method is a model for teaching that emphasizes well-developed and carefully planned lessons designed around small learning increments and clearly defined and prescribed teaching tasks (Direct Method, 2006).

Summary

Increasing the math competency of students in the United States has become a critical national educational goal. Teachers must try to increase the math competency of their current students while waiting for the various local, state and federal administrations to agree upon the best method to accomplish a positive change in curriculum and teaching methods.

The title of this research is *A Comparison of Two Teaching Methodologies in a Middle School Algebra Classroom.* The purpose of the study was to determine if a proposed change in teaching methodology would have a positive effect on the performance of middle school algebra students as measured by a chapter test. Of the two groups participating in the study, the change in teaching methodology was applied to the treatment group only. The changes involved the addition of constructive teaching methods to the daily direct instructional methods.

Chapter 2

LITERATURE REVIEW

Introduction

This chapter outlines four areas of research and practice which helped to establish the need for this study. The first section describes some of the basic approaches to teaching math. The second section examines the significance of Algebra in the overall scheme of education. The third section describes several curriculum enhancements which are particular to algebra. The final section addresses the need for adequate teacher training to allow for proper implementation of curriculum enhancements.

Approaches to Teaching Mathematics

Thornton identified three basic approaches to teaching math (as cited in Mourad, 2005, p.17). Some instructors follow a symbolic approach which is recognizing that letters are specific unknowns and that variables are letters which simply represent numbers. This approach emphasizes the routine rather than algebraic thinking. Others follow a patterns approach which begins with pattern generalization instead of focusing on the unknowns. This approach emphasizes the algebraic thinking that is so critical to continued academic success. The third approach, functions, also lends itself to algebraic thinking through representation using graphs, tables, words and symbols.

The National Council of Teachers of Mathematics Principles and Standards for School Mathematics (2000) also gives recommendations for how to teach and learn math. According to the NCTM (2000), the successful math teacher should be able to do the following : “select and use suitable curricular materials, use appropriate instructional tools and techniques to support learning, and pursuing continuous self-improvement.” Therefore the NCTM supports a varied method in order to effectively teach the skills necessary to be successful in mathematics education.

Significance of Achievement in Algebra in an Educational Career

Stacey and MacGregor (1999) indicate that the basis for success in algebra begins with the initial development of numbers, their properties and operations. If students learn to apply the mathematical operations they learn in their early academic years to large numbers, fractions and decimals, rather than simply arrive at an answer, they will better be able to apply the broad concepts taught in algebra.

Parker (2005) found that students who scored higher on a college mathematics placement exam accounted for a higher percentage of those who completed a four-year degree at that college. Johari (as cited in Mahmoud, 2005, p.11) also found that there is a strong relationship between mathematical skills and success in college. These findings are not partial to a specific course of study.

Higher education generally leads to an increased pay scale. Rose (2006) found that women who made higher gains on a standardized test in high school had larger earnings after high school. However, the same statistic did not represent men in this study. Marcotte, Bailey, Borkoski, and Kienzl (2005) found a positive relationship between a community college education and earnings. This relationship was greater for salaried workers than for hourly wage earners. Similar results were found in a study that examined the effects of a community college program for economically disadvantaged students (Brauchle & Hastings, 2003).

Algebra Curriculum Enhancements

There are a variety of curriculum enhancements that have been examined. Four that will be discussed are technology assisted learning, the use of writing, the use of calculators, and the use of manipulatives (objects, such as blocks, that a student is instructed to use in a way that teaches or reinforces a lesson).

Technology in the Mathematics Classroom

As students get older they often want to know how the subject matter being taught will help them in life. Kanning (1994) is using multimedia technology to answer that question. He wrote a laserdisc program that uses some of the basics of middle school mathematics: decimals, percents, patterns, to demonstrate their use in popular career choices. The students see the use of statistics to help save an endangered species and predict water needs for future Californians.

No discussion of technology in the classroom can be complete without bringing up the integration of computer technology into the teaching process. While most instructors do not think computers can take the place of the teacher in the classroom, several researchers have completed studies designed to assess the impact of computer learning in the mathematics curriculum. Clinkscales (2002) was able to address a unit on factoring polynomial expressions with both traditional classroom instruction and an online learning system. While the students' perceptions of the computer assisted learning were positive, the results indicated that there was not a significant difference between the two methods. Zhang (2005) conducted a similar experiment using the topic of triangles. He also found no significant difference between traditional classroom and computer instruction. However, like Clinkscales' study, the students who participated in the computer instruction reported positive experiences with the math unit. Arbuckle (2005) used computer assisted instruction and, again, achieved the same results: no significant difference, but the students reported a positive experience. These studies would suggest that incorporating the computer into the classroom, but not relying solely upon computer instruction would yield the best academic results for students, but further research is necessary.

Writing in the Mathematics Classroom

Teachers look for many ways to improve the competency level of their students. One method of curricular enhancement that shows the promise of improving student outcomes is incorporating writing into the math curriculum. Several studies (Baxter, 2002; Baxter, 2005; Burns, 2004; Hamdan, 2005) have shown student improvement through journaling or reflection about the lessons that have been taught. The teachers who have incorporated these methods have found not only improved test scores, but also a greater ability of the students to express what they have learned either verbally or with the written word. Austin (1998) found that students, especially females achieved higher pass rates in mathematics through implementation transactional writing .

Calculators in the Mathematics Classroom

Current educational discussions rarely take place without the mention of technology in the classrooms. One form of technology that is often talked about but not widely used yet in the classroom is the calculator. This includes standard calculators and graphing calculators. Milou (1999) found that using graphing calculators is controversial, but that higher math classes tend to use them more often. Milou also found that the graphing calculator was viewed as a motivational tool to encourage student participation through the use of technology. Willoughby (1992) found that the use of calculators could open the student's thought processes. He indicated that students should be encouraged to experiment with the calculators and the results garnered when the same numbers are entered in different patterns. While encouraging exploration of math concepts and understanding with the use of calculators should be encouraged, Pennington (1998) found that in order to see improvements in test results the students must be instructed in the proper use of the calculator to achieve the desired mathematical result.

Manipulatives in the Mathematics Classroom

In the search to find more tools for students to employ in the task of understanding mathematics concepts, one tool teachers may turn to is manipulatives. Many manipulatives, such as tangrams (a Chinese puzzle consisting of a square cut into five triangles, a square, and a rhomboid, which can be combined so as to form a great variety of other figures) (Dictionary.com, 2006) and unifix cubes (interlocking cubes of varied colors which can be used for counting, patterning and number sense) are used in the primary grades. Yet the purpose of their use is the same: to add to student learning and understanding of a concept. Using manipulatives may seem like a fun learning tool, but it can be simply a game if not applied in the correct strategy (Burns, 1996; Waite-Stupiansky & Stupiansky, 1998). Some of these strategies include, but are not limited to: discussing with the students why manipulatives are used, free exploration time, and clear guidelines for the use, sharing and storage of manipulatives. The students need to be responsible for the tools, but this comes with the knowledge of how the tools will add to their knowledge of a subject where the use of manipulatives has been implemented.

Teacher Training in Mathematics

Research is showing that teachers need to be prepared to teach math differently from the way they learned (Roupp, 1997). Roupp suggests that teachers get together, in a formal context, to do math. Because this professional development program involved elementary, middle and high school teachers, it allowed the participants to get a sense of the importance of developing algebraic thinking throughout a student's educational career. Cady (2006) found that as teachers gained experience during their first five years of teaching they became more receptive to a variety of techniques that could be used to implement learning objectives. The newly graduated teachers reported an ability to better utilize a variety of teaching tools as they spent more time in the classroom and became more comfortable with the subject matter. This would imply that teachers would be open to learning new techniques once they become confident in the classroom. Continued teacher training is important and can be accomplished (Crespo & Nicol, 2006), but the teachers must first gain some experience in the classroom in order to form their own educational beliefs and therefore be open to the ideas and practices of others. . One concept teachers might become more aware of as they gain experience and confidence is teaching younger students to think algebraically (Stump, Bishop, & Britton, 2003). Recognizing that the students need to practice the elementary mathematical concepts with larger numbers is part of the acquisition of knowledge that Stump speaks about.

Summary

Research has shown there is a need to improve the math curriculum in the United States. The importance of achieving curriculum improvement, in order to ensure future academic success, is also demonstrated in the research. The question that continues to arise is how to begin to facilitate improving the national math curriculum on more than a localized level. The research discusses a variety of methods to aid in the improvement of math curriculum. The use of manipulatives is one method used to improve math curriculum, and its use has been well documented, especially at the elementary level. This study was an attempt to determine the efficacy of using publisher recommended manipulatives in an eighth grade algebra classroom.

Chapter 3

METHODS

Introduction

This chapter addresses the procedural course of action for this study. The first section provides a statement of the problem and the research question addressed in the study. Then the research design is detailed as well as the procedures that were followed throughout the course of the project. The participants are described and the tools (the test that was used to measure change) are discussed and attached (see Appendices A & B) . The statistical measures that were used to analyze the data accumulated throughout the study were reviewed and the final section summarized the topics discussed in the chapter.

Statement of the Problem

It has been reported that mathematics teaching in the middle grades and beyond is mediocre at best (Silver, 1998). When compared to other countries, even top students fail to succeed at a high level. This would suggest that changes need to be made in the math curriculum and the methodology with which it is taught. While an individual teacher cannot make immediate changes to the entire math curriculum within a school or school district, he or she can make changes in the way the subject is taught within a specific class. The problem to be addressed by this research project was the continuing decline of mathematics competency in middle school students and the need for immediate interventions.

Research Question

Will eighth grade algebra students who receive "constructive" as well as "direct method" instruction perform better on a unit test than their counterparts who receive only direct method instruction? For the purpose of this study, constructive instruction included the use of manipulatives, reading the chapter aloud, the taking of notes, and practice. Direct instruction was characterized primarily by taking notes related to the lecture and completing practice problems.

Research Design

This study was quantitative in nature. The design was a pretest-posttest control group design (Leedy & Ormrod, 2005). This design involves two groups (in this case two classes of students) who were randomly assigned. The experimental group was tested, subjected to the treatment (constructive and direct method instruction) and tested again. The control group was tested, underwent no additional treatment, and tested again. Pretest-posttest conrol group design studies allow results to be analyzed for change, and, if there is a change, to eliminate alternate explanations for the change.

Procedures

To address the research question, "will eighth grade algebra students who receive constructive as well as direct method instruction perform better on a unit test than their counterparts who receive only direct method instruction," the procedures detailed below were followed. A class of 28 students comprised the control group, and a second class of 29 students comprised the treatment group.

Both classes were taught chapter two (Exploring Rational Numbers), using direct instruction, of the Glencoe Algebra I textbook (Collins et al., 1998, pp 70-132). All students were then given a review and the basic level, multiple choice, end of chapter test (see Appendix A) was administered.

Instruction of chapter three (Solving Linear Equations), for the control group, of the Glencoe Algebra I textbook (Collins et al., 1998, pp. 140-183) was direct instruction, utilizing both lecture and notes with examples. The instruction followed the unit progression of the seven sections outlined in chapter three of the Glencoe Algebra I textbook. Upon completion of the chapter the control group practiced the concepts taught in the unit by completing the study guide in the textbook. The members of the control group then took the basic level, multiple choice, end of chapter test (see Appendix B) for chapter three.

The treatment group began chapter three by reading orally the chapter preview of the Glencoe Algebra I textbook (Collins et al., 1998, pp. 140-141). The treatment group was then introduced to the use of manipulatives to help solve linear equations. Following the introduction the students were given the two rules for equation models and instructed in the use of cups, counters and equation mats (see Appendices C, D & E) to begin the Modeling Mathematics sections of the chapter. The students in the treatment groupwere then divided into small groups (2-3 students), given the necessary materials, and began to practice the modeling techniques. They then progressed through the chapter with the pattern of reading the sections aloud, working through any suggested manipulative activities, teacher lecture, examples, questions and homework. Upon completion of the chapter the treatment group practiced the concepts taught in the unit by completing the study guide in the textbook. The members of the treatment group took the basic level, multiple choice, end of chapter test (Appendix B) for chapter three.

Population

The control group consisted of 28 eighth grade students between ages 13 and 14 years. The experimental group consisted of 29 eighth grade students, also between ages 13 and 14 years. Both groups were mixed gender and ability. The control group had 17 girls and 11 boys, while the treatment group was comprised of 18 girls and 11 boys.

Instrumentation

A publisher generated, basic level, multiple choice test (pretest) was administered following the completion of the instruction and review of chapter two of the Glencoe Algebra I textbook (Collins et al., 1998). Another publisher generated, basic level, multiple choice test (posttest) was administered following the completion of instruction and review of chapter three of the Glencoe Algebra I textbook (Collins et al., 1998).

Data Analysis

Measures of central tendency were calculated to examine the outcomes of the chapter two and the chapter three end of unit tests for each class. A t-test was performed on the above means to determine if the difference was significant (Leedy & Ormrod 2006).

Summary

This chapter addressed the research question, "will eighth grade algebra students who receive constructive as well as direct method instruction perform better on a unit test than their counterparts who receive only direct method instruction," and the procedures that were used to address the question. The design was a pretest-posttest control group design. The population studied was a control group consisting of 28 eighth grade algebra students and an experimental group consisting of 29 eighth grade algebra students. The instruments consisted of a publisher generated pretest and posttest. The outcomes of the control and experimental groups were compared using measures of central tendency, and a *t* test was performed to determine if there was a statistically significant difference between the means.

Chapter 4

RESULTS

The purpose of this study was to determine if students who received "constructive" as well as "direct method" instruction would perform better on an end of unit test than students who received only the "direct method" instruction. For this purpose, one class of randomly assigned eighth grade students was designated as a control group and a second class of randomly assigned eighth grade students was designated as an experimental group. Both classes took an end of unit exam on chapter two (Exploring Rational Numbers) of the Glencoe Algebra I textbook (Collins et al., 1998). As instruction of chapter three (Solving Linear Equations) of the Glencoe Algebra I textbook (Collins et al., 1998) began, the control group continued as usual with "direct method" instruction. However, the experimental group was taught the same chapter material using "constructive" methods. In addition to the methods used to instruct the control group, the experimental group participated in several additional activities, recommended by the publishers, to enhance their understanding of the material presented in the chapter. At the conclusion of instruction for chapter three, both groups completed a review of the material and took an end of unit exam.

Measures of central tendency were calculated to examine the outcomes of the chapter two and chapter three tests for each class. The results were examined further based on gender. Standard deviation scores were calculated on the above measures to determine the variability of the results. A t-test was also calculated to test for a statistically significant difference between the means.

Pretest

The two randomly assigned classes involved in this study were administered a publisher generated test (pretest) to assess the ability of the classes and to provide a baseline for comparison. The test was administered following a chapter dealing with the exploration of rational numbers. Although there were a few new topics contained within the chapter, the students had received previous instruction on many of the topics during their course in Pre-Algebra the previous school year. Descriptive statistics for this test can be found in Table 1.

Table 1

Descriptive Results of Pretest

Variable	N	Mean	Median	Mode	Min	Max	Standard Deviation
Control	28	29.54	32	32	14	43	7.65
Female Control	17	28.76	32	32	16	43	7.58
Male Control	11	30.73	33	34	14	41	7.96
Treatment	28	29.61	31.5	33	10	41	7.88
Female Treatment	17	28.76	32	35	10	41	8.76
Male Treatment	11	30.91	31	33	20	41	6.46

All Student Pretest Scores

The class mean for the control group (μ_1) was 29.54 (out of 40) or 74%, while the mean for the experimental group (μ_2) was 29.41 or 74%. A comparison of these scores appeared to show no significant difference between the two classes on the pretest. The null hypothesis (H_0) stated that the means of the two groups were equivalent, and that was tested against the alternative hypothesis (H_a) which stated that the means of the two groups were not equivalent. Symbolically, this is represented as H_0: $\mu_1 = \mu_2$ and H_a: $\mu_1 \neq \mu_2$. A 2-sample t-test was performed on the data. A t-statistic of -0.033 and p-value of 0.487 was found when the overall means for the classes was evaluated. At a significance level of $\alpha = 0.05$, the t-test showed a failure to reject the null hypothesis. Therefore, the means of the control and treatment groups, on the pretest, were statistically equivalent.

Female Pretest Scores

The class mean for the females in both the control group (μ_1) and the treatment group (μ_2) was 28.76 (out of 40) or 72%. A comparison of these scores appeared to show no significant difference between the two means. The null hypothesis (H_0) stated that the means of the two groups were equivalent, and that was tested against the alternative hypothesis (H_a) which stated that the means of the two groups were not equivalent. Symbolically, this is represented as H_0: $\mu_1 = \mu_2$ and H_a: $\mu_1 \neq \mu_2$. A 2-sample t-test was calculated on the data. A t-statistic of 0.000 and p-value of 0.500 was found when the means for the females from both classes were evaluated. At a significance level of α =

0.05, the t-test showed a failure to reject the null hypothesis. Therefore the means of the female control and female treatment groups, on the pretest, were not statistically different.

Male Pretest Scores

The mean for the males in the control group (μ_1) was 30.73 (out of 40) or 77% while the mean for the males in the treatment group (μ_2) was 30.91 or 77%. There does not appear to be a significant difference between these two means. The null hypothesis (H_0) stated that the means of the two groups were equivalent, and that was tested against the alternative hypothesis (H_a) which stated that the means of the two groups were not equivalent. Symbolically, this is represented as H_0: $\mu_1 = \mu_2$ and H_a: $\mu_1 \neq \mu_2$. A 2-sample t-test was calculated on the data. A t-statistic of -0.050 and a p-value of 0.480 was found when the means for the males from both classes were evaluated. At a significance level of $\alpha = 0.05$, the t-test showed a failure to reject the null hypothesis. Thus the means of the male control and male treatment groups were not shown to be statistically different at the beginning of the study.

Posttest

After both classes received three weeks of instruction and review on an algebra chapter dealing with solving linear equations, a publisher generated posttest was administered. The results of the test were used to assess the efficacy of the chapter activities as prescribed by the publisher.

Table 2

Descriptive Results of Posttest

Variable	N	Mean	Median	Mode	Min	Max	Standard Deviation
Control	28	15.57	16	20	6	24	5.23
Female Control	17	15.65	16	14	6	24	5.01
Male Control	11	15.45	18	20	6	22	5.80
Treatment	28	15.93	14	14	8	26	4.70
Female Treatment	17	14.71	14	14	10	24	4.06
Male Treatment	11	17.82	18	20	8	26	5.17

All Student Posttest Scores

The class mean for the control group (μ_1) on the chapter three posttest was 15.57 (out of 40) or 39%, while the mean for the treatment group (μ_2) was 16.07 or 40%. There does not appear to be a significant difference between these two means. The null hypothesis (H_0) stated that the means of the two groups were equivalent, and that was tested against the alternative hypothesis (H_a) which stated that the means of the two groups were not equivalent. Symbolically, this is represented as H_0: $\mu_1 = \mu_2$ and H_a: $\mu_1 \neq \mu_2$. A 2-sample t-test was calculated on the data. A t-statistic of -0.282 and a p-value of 0.390 was found when the means from both classes were evaluated. At a significance level of $\alpha = 0.05$, the t-test showed a failure to reject the null hypothesis. Therefore, the means of the control and treatment groups, on the posttest, were statistically equivalent.

Female Posttest Scores

The mean for the females in the control group (μ_1) was 15.65 (out of 40) or 39% while the mean for the females in the treatment group (μ_2) was 14.71 or 37%. There does not appear to be a significant difference between these two means. The null hypothesis (H_0) stated that the means of the two groups were equivalent, and that was tested against the alternative hypothesis (H_a) which stated that the means of the two groups were not equivalent. Symbolically, this is represented as H_0: $\mu_1 = \mu_2$ and H_a: $\mu_1 \neq \mu_2$. A 2-sample t-test was calculated on the data. A t-statistic of 0.563 and a p-value of 0.291 was found when the means for the females from both classes were evaluated. This was not enough to reject the null hypothesis, therefore, the means of the female control and treatment groups, on the posttest, were statistically equivalent.

Male Posttest Scores

The mean for the males in the control group (μ_1) was 15.45 (out of 40) or 39% while the mean for the males in the treatment group (μ_2) was 17.82 or 45%. There does appear to be a significant difference between these two means. The null hypothesis (H_0) stated that the means of the two groups were equivalent, and that was tested against the alternative hypothesis (H_a) which stated that the means of the two groups were not equivalent. Symbolically, this is represented as H_0: $\mu_1 = \mu_2$ and H_a: $\mu_1 \neq \mu_2$. A 2-sample t-test was calculated on the data. A t-statistic of -0.910 and a p-value of 0.192 was found when the means for the males from both classes were evaluated. This was not enough to reject the null hypothesis, therefore, the means of the male control and treatment groups, on the posttest, were not statistically different.

Summary

This chapter revealed the results of the tests administered in order to answer the research question, "will eighth grade algebra students who receive constructive as well as direct method instruction perform better on a unit test than their counterparts who receive only direct method instruction." Each class was administered a Chapter Two and Chapter Three test and both sets of results were analyzed using measures of central tendency. The outcomes of the statistical analyses are reviewed in the following chapter.

Chapter 5

DISCUSSION

Introduction

As the math competency of middle school students continues to decline (Silver, 1998) it is important for teachers, currently in the classroom setting, to implement strategies that will reverse the declining trend. The purpose of this study was to determine if students who received "constructive" as well as "direct method" instruction would perform better on an end of unit test than students who received only "direct method" instruction. The design of the study was a pretest-posttest control group design with two groups of eighth grade algebra students randomly assigned to a control group and a treatment group. This chapter discusses the results of the study and will address any limitations of the study as well as recommendations for future study.

Summary

This quantitative study used two sections of an eighth grade algebra class. The project design was a pretest-posttest control group design (Leedy & Ormrod, 2005) where the two sections of an eighth grade algebra class were assigned randomly to either the control group or the experimental group. The control group contained 28 students, while the experimental group consisted of 29 students.

Both classes were taught a chapter, using the same instructional method, and then a publisher generated chapter test (pretest) was administered. The outcome of that initial chapter test was used as the pretest. The students were then taught the following chapter using two different teaching methodologies.

The control group received the same instruction as the previous chapter which included lecture, notes and practice problems. The experimental group received the same instruction as the control group, but also received additional teaching methodologies in the form of reading the chapter lessons and using publisher suggested manipulatives to assist in the formation of the proper procedures needed to do the work. Following the completion of instruction another publisher generated unit test was administered, and was used as the posttest. The outcomes of both tests were analyzed with the calculation of measures of central tendency and a t-test was performed to look for a statistical difference between the two means.

Conclusions

The following sections will provide a review and discussion of the pretest and posttest results. There will also be a discussion of the posttest outcomes with regard to the pretest outcomes.

Pretest

The pretest was administered to establish a performance baseline for both the control and the experimental groups. Examined individually, the outcomes for the control group varied between 35% and 100.08% correct while the outcomes for the experimental group varied between 25% and 100.03% correct. The means for the pretest were determined to be statistically equivalent for both the control and treatment groups.

These results indicate that both the control group and the experimental group had demonstrated approximately equivalent skill levels prior to beginning instruction of the next unit. The same can be said when examining the comparison between the females of the control versus treatment groups or between the males of the control versus the treatment groups. The equivalent beginning levels, in spite of the classes being randomly assigned, were the result the researcher was hoping for to begin the study.

Posttest

The posttest was administered to answer the research question, "Will eighth grade algebra students who receive "constructive" as well as "direct method" instruction perform better on a unit test than their counterparts who receive only direct method instruction?" The posttest outcomes for the control group varied between 15% and 60% correct while the outcomes for the experimental group varied between 20% and 65% correct. The means for the posttest were determined to be statistically equivalent for both the control and treatment groups. These results indicate that the addition of constructive methodology made no statistical difference in the student outcome of the algebra unit. The same can be said when comparing outcomes of the female students in the control versus treatment groups or the male students in the control versus treatment groups.

Limitations

This study was an attempt to determine if additional teaching methodologies, in the form of publisher suggested manipulatives, would have a positive impact on the student outcomes as measured by a chapter test. Three manipulatives were suggested, but only one was appropriate for eighth grade algebra students. The majority of students involved in the study had been exposed to basic algebra theory in the sixth grade, so solving linear equations, in the simple manner presented, was a review. The “cups and counters” manipulatives (see Appendix C & D) did not appear to appeal to this level of student because of its beginning level simplicity. However, the “angles of a triangle” manipulative (see Appendix E) appeared to solidify the concept of the sum of the measures of the angles within a triangle. The majority of the students in the treatment group were able to “construct” this lesson of sums by themselves.

Although the study was not designed with a pretest-posttest comparison in mind, when reviewing the results of the testing (see Appendices F, G, H & I) it was apparent that a discussion of this topic was required. The means for both the control and treatment groups, recorded for the pretest, were 74%, while the means for both the control and treatment groups, recorded for the posttest, were 40%. While the researcher was unable to attain a significant difference from the implementation of additional teaching methodologies, there was cause for concern related to the marked (~35%) drop in test scores from one chapter to the next. To possibly account for this drop a brief description of the actual posttest atmosphere follows.

The control and treatment groups are two eighth grade algebra classes which are consecutively scheduled around a 15 minute break period. The researcher proctors all exams. On the day the posttest was administered it was noticed, approximately 10 minutes into the testing period of the control group, that the sounds in the classroom were different from the usual “test-taking” sounds. The researcher, while walking through the classroom, noticed a majority of the students struggling to complete the questions. At this time the researcher began to take the exam and noticed that the questions were worded in a completely different manner from any of the practice problems the students had encountered throughout the study of the chapter material. The students in the control group were allowed to complete the test to the best of their ability and quietly leave the classroom. Following the 15 minute break the students in the treatment group began to take the same exam. The “sounds of frustration” were again noticed approximately 15 minutes into the test period. The students in the treatment group were allowed to complete the exam to the best of their ability and quietly leave the classroom. The testing protocol was the same for both groups, but the posttest, upon further examination, did not reflect the thought processes that had been established by the use of the publisher suggested materials.

The time frame of this study may have affected its outcome. It was difficult to complete the extended procedures for the treatment group in the time allotted. Having found the discrepancy between the way the material was taught and the way it was tested, a longer time frame may have allowed the researcher to retest the students with a test that more accurately reflected the materials taught in the chapter.

Recommendations for Improving Practice

The first recommendation for impending practice discusses the suggested manipulatives. The first two manipulatives (see Appendix C & D) would be better suited for use in a lower level math class where the concepts of solving linear equations are initially being taught. The student perception of the use of these manipulatives at the introductory level would hopefully be beneficial in the acquisition of the concepts and constructs needed for more advanced mathematical models. The last of the suggested manipulatives (see Appendix E) is a tool which engages the students at the eighth grade algebra level and it is recommended that its use continue in the classroom. It is also recommended that research be conducted to discover additional manipulatives to be considered for use at the eighth grade algebra level.

The second recommendation for improving practice discusses the use of publisher generated unit tests. If the publisher tests are to be used they should be reviewed prior to testing to attempt to review the correlation between the way the test questions are written and the way the material is taught. If the method of questioning is determined to be valuable, the teaching methodology and/or the review strategies should be adapted in order to avail the students of the knowledge necessary to successfully navigate the test material.

Recommendations for Further Research

The first recommendation for further research involves the use of the two manipulatives which have been recommended for use at the introductory algebra level. A similar study could be designed, using less experienced students, to determine if the manipulatives would have a positive impact on the student outcomes of a lower level math class.

The second recommendation would be to repeat this study with manipulatives which are found to be more age appropriate. It is also recommended that the repeated study utilize a teacher designed pretest and posttest which more accurately reflects the knowledge the students are thought to acquire while progressing through the chapter.

A third recommendation would involve a similar study but focused on a smaller section within the chapter. Because one of the manipulatives (see Appendix E) was found to engage the students in the constructive learning process, it is suggested that the study be confined to the section on geometry which utilizes the manipulative.

The topic of the best methods of teaching mathematics is a topic that will, hopefully, continue to be examined by researchers and teachers in the classroom. Whether it be the use of manipulatives or the introduction of writing and the introduction of technology in the math classroom, researchers must continue to examine the efficacy of these tools in order to continue to strive for the teaching methodology that will result in the utmost success for the students.

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APPENDIX A

Publisher Generated Pretest

The pretest (Chapter 2 Test 2C) used in this project is copyrighted and is available from the copyright holder as follows:

Collins, W., Cuevas, G., Foster, A., Gordon, B., Moore-Harris, B., Rath, J., et al. (1998). *Algebra 1: Integration, Applications, Connections; Exam Material.* Columbus, Ohio: Glencoe/McGraw-Hill, pp. 33-34.

APPENDIX B

Publisher Generated Posttest

The posttest (Chapter 3 Test 2C) used in this project is copyrighted and is available from the copyright holder as follows:

Collins, W., Cuevas, G., Foster, A., Gordon, B., Moore-Harris, B., Rath, J., et al. (1998). *Algebra 1: Integration, Applications, Connections; Exam Material.* Columbus, Ohio: Glencoe/McGraw-Hill, pp. 61-62.

APPENDIX C

First Recommended Manipulative

The first recommended manipulative (Solving One-Step Equations) used in this project is copyrighted and is available from the copyright holder as follows:

Collins, W., Cuevas, G., Foster, A., Gordon, B., Moore-Harris, B., Rath, J., et al. (1998). *Algebra 1: Integration, Applications, Connections.* Columbus, Ohio: Glencoe/McGraw-Hill, pp. 142-143.

APPENDIX D

Second Recommended Manipulative

The second recommended manipulative (Solving Multi-Step Equations) used in this project is copyrighted and is available from the copyright holder as follows:

Collins, W., Cuevas, G., Foster, A., Gordon, B., Moore-Harris, B., Rath, J., et al. (1998). *Algebra 1: Integration, Applications, Connections.* Columbus, Ohio: Glencoe/McGraw-Hill, p. 155.

APPENDIX E

Third Recommended Manipulative

The third recommended manipulative (Angles of a Triangle) used in this project is copyrighted and is available from the copyright holder as follows:

Collins, W., Cuevas, G., Foster, A., Gordon, B., Moore-Harris, B., Rath, J., et al. (1998). *Algebra 1: Integration, Applications, Connections.* Columbus, Ohio: Glencoe/McGraw-Hill, p. 164.

APPENDIX F

Pretest Results (Control Group)

All Students Scores

Student #	Score
1	43
2	41
3	39
4	38
5	37
6	36
7	34
8	34
9	33
10	33
11	33
12	32
13	32
14	32
15	32
16	30
17	30
18	29
19	28
20	26
21	22
22	22
23	22
24	21
25	20
26	18
27	16
28	14

Female Student Scores

Student #	Score
1	43
2	38
3	37
4	33
5	33
6	32
7	32
8	32
9	32
10	30
11	26
12	22
13	22
14	22
15	21
16	18
17	16

Male Student Scores

Student #	Score
1	41
2	39
3	36
4	34
5	34
6	33
7	30
8	29
9	28
10	20
11	14

APPENDIX G

Pretest Results (Treatment Group)

All Students Scores

Student #	Score
1	39
2	41
3	41
4	41
5	37
6	35
7	35
8	35
9	33
10	33
11	33
12	33
13	33
14	32
15	31
16	30
17	28
18	28
19	28
20	27
21	26
22	24
23	20
24	20
25	20
26	18
27	18
28	10

Female Students Scores

Student #	Score
1	41
2	39
3	37
4	35
5	35
6	35
7	33
8	33
9	32
10	28
11	28
12	27
13	20
14	20
15	18
16	18
17	10

Male Student Scores

Student #	Score
1	41
2	41
3	33
4	33
5	33
6	31
7	30
8	28
9	26
10	24
11	20

APPENDIX H

Posttest Results (Control Group)

All Student Scores

Student #	Score
1	24
2	22
3	22
4	22
5	20
6	20
7	20
8	20
9	20
10	20
11	18
12	18
13	16
14	16
15	16
16	16
17	14
18	14
19	14
20	14
21	12
22	10
23	10
24	10
25	8
26	8
27	6
28	6

Female Student Scores

Student #	Score
1	24
2	22
3	22
4	20
5	20
6	18
7	16
8	16
9	16
10	14
11	14
12	14
13	14
14	12
15	10
16	8
17	6

Male Student Scores

Student #	Score
1	22
2	20
3	20
4	20
5	20
6	18
7	16
8	10
9	10
10	8
11	6

APPENDIX I

Posttest Results (Treatment Group)

All Student Scores

Student #	Score
1	26
2	24
3	24
4	20
5	20
6	20
7	20
8	20
9	20
10	18
11	18
12	16
13	16
14	14
15	14
16	14
17	14
18	14
19	14
20	14
21	12
22	12
23	12
24	12
25	10
26	10
27	10
28	8

Female Student Scores

Student #	Score
1	24
2	20
3	20
4	20
5	16
6	14
7	14
8	14
9	14
10	14
11	14
12	12
13	12
14	12
15	10
16	10
17	10

Male Student Scores

Student #	Score
1	26
2	24
3	20
4	20
5	20
6	18
7	18
8	16
9	14
10	12
11	8