Running Head: Increase in Academic Achievement

Infusing Math Manipulatives: The Key to an Increase in Academic Achievement in the Mathematics Classroom

Final Research Proposal

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Abstract

Manipulatives are the way to our future and the way to new knowledge. No matter where we turn or what we do, we as a society are using some form of manipulative in our lives. Mathematics is changing all of the time from basic arithmetic to basic calculus. Therefore, children in today's classroom deserve to have that extra tool to help them grasp the concept, in order to form mastery in mathematics. Without hands on experience in the classroom, how would students learn? Many children are influenced and motivated by the use of manipulatives. That's why is at most important that manipulatives are used to help increase students' academic achievement.

Chapter I:

Problem Statement

Researchers have wondered what difference it would make if manipulatives were added to everyday learning in the mathematics classroom. Furthermore, do they lead to a significant increase in student achievement? In today's mathematics classrooms, students are being introduced to manipulatives but it's not a consistent strategy. Manipulatives help provide students with a greater understanding of certain mathematical problems and skills. Since researchers have seen the negative effects of using manipulatives, they have also seen the positive impact manipulatives have in students' ability to learn. This researcher will study and explain the relationship of mathematics achievement and the use of manipulatives in the elementary classroom.

Elements of the Problem

Current students seem to not learn at the same pace as students' fifthteen years ago because of the lack of assistance that they receive in their primary years. Scudder and Uttal (1997) claim that mathematics educators around the world believe students learn better when they are taught by experiencing the use of manipulative devices. Elementary students today need higher assistance because a large percentage of our students are not getting the help that they need during regular instructional time.

Salaam (2006) suggests that due to a lack of interest and understanding of the subject many students struggle in mathematics. McClung (1998) suggest that the use of manipulative devices produces greater mathematics achievement than a lesson not incorporating them.

Therefore, students achieve higher when working with different hands-on objects that are considered to be manipulatives. However, in some curriculums manipulatives are not a high priority for teachers. Picciotto (1993) implies teachers become ineffective due to a lack of understanding the material. Manipulatives provide an environment to teach math as well as pedagogy to teachers. Since most curriculums in the public school system have pacing charts to assist with helping teachers stay on task in a systematic order, there is no time for other instruction to be implemented in a timely fashion.

Purpose of Study

The purpose of this quantitative research is to understand how the use of manipulatives can increase math grades of low achievers in elementary school. Picciotto (1993) implies that manipulatives are an extraordinary tool to help reach weaker students, but that is not their only purpose. When students are able to visually see a mathematical concept in action, a deeper level of comprehension occurs; this will then allow the low-academic achievers and high-level achievers to feel motivated to learn.

Research Questions

Based on the review of literature, the researcher will focus on the following research question: Is there a statistically significant increase in academic achievement for elementary students when they use manipulatives?

Hypothesis

This researcher will test the following null hypothesis: First grade, low academic achievers who use manipulatives during instruction, will not perform significantly better than the control group which does not use manipulatives during instruction. The

confidence interval for this one-sample, paired-data t-test will be 0.05.which will lead to a significant increase in their academic achievement by the use of manipulatives during instruction.

Objectives

The researcher's objective is to determine if manipulatives are related to a significant difference in the performance level of students, within the mathematics classroom. Students will be able to show a difference in academic achievement through understanding and by executing mathematical problem solving through the use of manipulatives.

Definition of Terms

The following definitions are used for constructs in this research.

Math Manipulatives - Merriam Webster Dictionary (2006) defines manipulatives as any object that a student is instructed to use that in a way teaches or reinforces a lesson.

Mathematics - Hinzman (1996) implies that mathematics is the science of numbers, sets and their general operations. Furthermore, mathematics involves relations, combinations, space configurations and their structure, in addition to measurement and transformations.

Hands-on Activities – Brown (2006) defines it as activities using objects that appeal to several senses, [which] can be touched, handled or moved.

Chapter II

Literature Review

Roy & Roy (2006) explain that manipulatives are everywhere we turn, from street signs to our grandfather's clock. The researcher has provided several examples that various researchers have implemented to enhance learning through the use of manipulatives. Faggella and Hayes (1988) believe that "our role, as adults, is to help each child recognize mathematics situations in their activities and encourage the children to apply their knowledge and experiences to any problems that occur" (p.9). These activities involve tools that are used as manipulatives to help students solve the given situation or problem. In this chapter the researcher will review studies on the use of manipulatives in the classroom and how they have a significant increase in academic achievement. This chapter review will provide evidence that students' academic achievement does increase if the use of manipulatives is integrated into the classroom.

Manipulatives

VanCleave's (1991) claim that math should be a fun experience and encouraging desire to investigate topics involving math with unique strategies and with less frustration. "Mathematical tools can build a foundation for children to understand concepts, which can then initialize an abstract understanding" (Hiebert, 1997). Manipulatives can become those mathematical tools to build a firm foundation. Picciotto (1993) suggest that the foundation of mathematics helps facilitate the leaps to abstraction that are embedded and embodied in the notation of addition and subtraction. Manipulatives allow the students to become more comfortable with the lesson in the

classroom. Manipulatives also give teachers a chance to show students different approaches that they can take to solve a particular problem. Burch (2006) claims a math teacher should provide students with an excess of fascinating materials that may include things in real life that involve mathematics. In the classroom manipulatives should be a necessary requirement in the math curriculum. Jones (1986) defines manipulatives as materials that are physically handled by students in order to help them see actual examples of mathematical principles at work, and they are designed (or their use is designed) with the idea of illustrating a certain mathematical principle. Manipulatives help promote visual learning in the classroom and they help students have self-determination to increase learning.

There are two types of manipulatives that can be used in the classroom and they are concrete and virtual manipulatives. The difference between the two is their physical nature (Olkun, 2003), since concrete manipulatives involves active touch. These concrete manipulatives can be things like building blocks, color sticks, counters or other physical things that can be used mathematically. Knap and McCrae (1999) explain the effects of using pictures such as red and blue counters to solve one-step subtraction and addition equations. They also believe that in order for students to do arithmetic well, in their heads, it is helpful to find simple ways of calculating by using pictures to help students grasp a visualization.

Students Achievement

Remer and Moyer (2005) claim mathematical tools build a foundation for students to comprehend concepts that initializes an abstract for their conceptual

understanding". Raphael, Sowell and Wahlstrom (1989) explain some studies show that student achievement levels are related to teachers' experience in using the manipulatives.

In another study, Olkun (2003) evaluates 4^{th} and 5^{th} graders' achievement when given mathematics pre-tests and post-tests for appropriate group placement. The students were separated into three groups, the control group, concrete group and computer or virtual group. The researcher provided students with a setting where they could search for functional uses of geometric shapes and thereby discover the relationship between 2D geometric figures, (Olkun, 2003).

After the study was complete, the researcher suggested that solving geometric puzzles with concrete or computer manipulatives led to a positive effect on students geometrical reasoning; the only differences were shown in the grade levels, where the 4^{th} graders did not gain as much as the 5^{th} graders during the pre-test and post-test. Whether concrete or virtual manipulatives, both have a strong effect based on the mean of the scores of this study.

In contrast, Williams (2001) demonstration of counting coins, focused on younger children by illustrating ways they can look at coins as manipulatives. She uses the addition technique by displaying the plus sign (+) between each individual penny, nickel, dime or quarter ending with an equal sign (=). Williams' method concentrates solely on younger elementary students in K-2. At this age, students need to see pictorial images that incorporate the basic mathematic symbols to help them through their instructional knowledge.

Manipulatives in the classroom

The use of manipulatives with the curriculum standards can create effective classroom learning. Burch (2006) claims when students are actively learning using manipulative materials they are able to apply what they learn in a more personal way to their own lives, thus creating a bridge between concrete and abstract learning. The best way for children to learn is through plenty of hands-on modeling.

Krech (2000) uses chocolate, a tasty manipulative; to demonstrate three basic and important ideas about fractions by breaking a Hershey ™ bar neatly along the lines to result into 12 pieces with equal parts. This demonstration introduces discovery learning to the students, because it allows them to explore through hands-on interaction with the chocolate manipulatives. The students seemed to enjoy the manipulative and hands-on learning more than the book work during this lesson on fractions. During the Krech demonstration, students were able to carry a visual image in their mind, so that they would be able to solve a similar problem in the near future. Knap and McCrae (1999) explains the effects of using pictures such as red and blue counters to solve one-step subtraction and addition equations. They also believe that in order to do arithmetic in your mind, it helps to focus on calculating through the use of visual pictures, which leads to better and faster calculating. This book shows the different color counters that are usually found in many elementary classrooms, to help them learn how to solve basic subtraction and addition problems. Counters are circle pieces that are similar to the bingo pieces that enable the students to have hands-on experience to help them focus on the lesson.

Bushell and Fueyo (1998) claim there is a strong need for the concrete and virtual manipulatives and arithmetic instruction because it is a core component of the elementary school curriculum. For example, a critical component in the mathematics classroom is the number line because it allows students to investigate relationships between positive and negative numerical numbers.

Bushell and Fueyo, (1998) suggest if students can see any two numbers on the number line, then they can compare and determine the difference between them.

Summary of Literature

Much evidence on the effectiveness of mathematics manipulatives is found in the literature. Heddens (1997) states that learning and mastering the basic skills of mathematics allows for student achievement in the subject. Moch's (2001) study indicated that students enjoyed having the opportunity to uncover and think through activities using manipulatives, and they looked forward to future opportunities to investigate other concepts. Teachers and students find this type of learning tool to be interesting in the classroom and a good learning experience. Therefore, there is a need for further investigation, since the argument of the use of manipulatives is still being debated to this day. Manipulatives, no matter concrete or virtual, are likely to increase the conceptual knowledge of each individual student. Picciotto (1993) claims not only do manipulatives in no way inhibit the learning of the concept, but also they provide both motivation and an additional arena. Manipulatives can be used as a motivation and as a learning tool for success. They are the bridge that we need as teachers to fill the gaps of

our students' conceptual knowledge. It is imperative that we look for different things that will help are children succeed in education.

Chapter III: Methodology

Research Design

For the purpose of this quantitative research design, this researcher will rely on suggested strategies of implementing manipulatives in mathematics through the use of counters. The researcher will give a pre-test to compare the control group and the experimental group. The pre-test score will be used to calculate an average for each group before the instruction process. In addition to the pre-test, a post-test will be used to calculate an average for each group after instruction of the control and experimental groups. The researcher will analyze the two averages from the pre-test and post-test, to see if a statistically significant difference occurred over an instructional period of time. A two sample, paired data t-test will be used for both a control and experimental group to analyze where each group of students' stand, as far as their prior knowledge versus their instructional knowledge, to determine their difference in score.

Theoretical Framework

Based on the research design, there is no need to apply a theory. For the verification of reading purposes, this researcher does acknowledge and understands the need for a theoretical framework, the present section is included for consideration.

Sampling

This researcher will use a fixed-effects model in spite of the use of inferential statistic to study students from two first grade self-contained classrooms in Detroit, Michigan. The students are currently in an instructional enrichment program at the school, and are the participants in a two sample paired data T-test. Both groups consisted

of 8 students who were involved in the instructional enrichment program. This researcher will administer a pre-test, teach the lesson, and then administer a post-test. This study of the findings cannot be used to project outcomes of other studies because findings may differ due to the restrictions of the sampling.

Variables

The independent variable will include the use of manipulatives and the dependent variable is academic achievement. The experimental group will be provided instruction with manipulatives but they will not be allowed to use the manipulatives on the pre-test and post-test. The control group will be provided instruction without the use of manipulatives at any given time. The lessons will be taught by the researcher, so there will not be influence of any kind from outside sources. One might assume that personal biases are introduced at this point, however that is not correct. The researcher is administering the lessons because she has investigated and is knowledgeable about the effectiveness of manipulatives in the mathematics classroom. Personal biases are not likely to occur because the proof of the research speaks for itself.

Methods of Data Collection

The data will be generated by using a pre-test and post-test. The pre-test and post-test will be the same for both groups but, the pre-test and post-test will not be identical. Students will not be informed; pre-test scores will not be included in their course grades until after they have taken them.

Data Analysis Procedures

Once data has been generated, a two sample, paired data t-test, with a confidence interval of .05 to analyze the data collected from the pre-tests and post-tests will be utilized.

Ethics and Human Relations

The researcher informed all participants that certain risk may accompany the research, but there are no serious risks involved while participating in this research. To take further precautions to protect the safety of the students, the following steps were taken: 1. The school's name, where the study is being done, will not be mentioned nor will any students or teachers names be identified; 2. Fictitious names will be assigned to each participant along with where the study is being done, so that there is no influences or changes to the environment due to the research being done; 3. Permission will be obtained by the appropriate faculty and staff members at Marygrove College; 4. The researcher will ensure that the parents of the participating students sign a consent to have their students in all school efforts, including research, video tapings and photographs, but in addition parents of the students participating will be notified and required to complete and informed consent form prior to the study provided by the researcher. All necessary steps will be taken to protect the human rights for all that participate.

Timeline

This study will be conducted over a one week time period. The math lesson will take place in two twenty-five minute class sessions for each group. Students will be able to take the pre-test on the first day. They will receive a 25 minute lesson for the next three days, and then take the post-test on the fifth day.

Summary

Although a great deal of research has already been conducted on students' academic achievement ability, it is imperative to investigate the relationship between the use of manipulative materials and the effects that they have on students' academic

achievement. The research design will show how students achieve while learning with hands-on tools in the mathematics classroom and their attitudes towards mathematics. Students need motivation to grasp and execute different mathematical concepts as well as create conceptual knowledge for future endeavors. Brown (2006) claims that manipulatives are not just fillers for class time; they are the keys to making the connection from abstract to concrete understanding in everyday situations. That is why manipulatives are important to use to increase the ability of students academic achievement.

Chapter IV: Analysis of Data

This chapter focuses on the data collected during this research. It will discuss the implications of the data as it relates to the research question reviewed.

Purpose of Study

The purpose of this study was to determine how the use of manipulatives can improve the grades of low achievers. This investigation focused on a group of students from two different classes, where one had the traditional teaching style and the other the experimental group with the manipulatives. A grading scale that had percentages 0 to 100 was used to determine the difference in scores from the pre-test and post-test.

Subjects

The control group used in this study consisted of eight 1st grade students in a self-contained classroom at a Detroit Public School, who were taught subtraction and addition using numbers 1 thru 20, with out the use of manipulatives during instructional time. The experimental group used in this study consisted of eight 1st grade students in a self-contained classroom at a Detroit Public School, but they had the privilege of having the use of manipulatives during instructional time only.

Homogeneity

The pre-test (Appendix A), was given to both groups of students to find out what level the students were performing on addition and subtraction. Assessing the data given in Appendix C, the averages of the pre-test scores of the two groups showed that they were both at equal level in the subject area of addition and subtraction. Based on the results of the pre-test averages, as shown in Table 1, the assumption was made that the groups were similar, therefore the study could be continued.

Table 1

Pre-Test Scores

Addition and Subtraction

Group	Number	Mean
Control	**8**	**48.75**
Experimental	**8**	**40.00**

Research Question

Based on the Research Design and the Review of Literature there are variables that reveal how the use of mathematical manipulatives in the classroom can improve the grades of low achievers. Therefore, the research question is "Is there a statistically significant increase in academic achievement in mathematics for elementary students, when they use manipulatives?"

Findings and Interpretations

This one week experiment took place on September, 2007. During this period of time, the control and experimental group were given an addition and subtraction pre-test. The students in the control group, for the next three days, were taught a addition and subtraction lesson, while the experimental group of students were given counter blocks to use for counting and subtracting numbers between 1 and 20. On the fifth day of instruction, the students in both groups were given a post-test (Appendix B). The students in the experimental group were not allowed to use manipulatives on the post-test. The same students were given the post-test that were given the pre-test. Using the

raw data in (Appendix C), a two-sample, paired data t-test was run on both groups' post-test scores at the .05 level to determine if there were statistical differences.

TABLE 2

Post-test Scores

Addition and Subtraction

Group	Number	Mean	T-Score
Control	**8**	**90.00**	
Experimental	**8**	**76.25**	
T-Score			**1.860**

As shown in Table 2, for df=8 participants, at 0.5 CI, the critical t-value of 0.334116 required to reject the null-hypothesis is 1.860. Although, there was an increase in scores, the increase was not powerful enough to compel us. Therefore, the change between the two groups is statistically significant at .05. The researcher has to accept that the use of manipulatives during instruction can generate a statistically significant increase in students' achievement in adding and subtracting whole numbers.

Further analysis of the post-test data from (Appendix C) has indicated that the highest percentage scored by an individual student in the control group in adding and subtracting whole numbers was 100, while the lowest percentage scored was a 70, with an average of 90.00. In the experimental group the highest score was also 100, the lowest score was 50, and the average was 76.00.

Chapter V: Summary, Conclusion, Recommendations

Summary

This research study was conducted during the 2007-2008 school year in the Detroit Public School District. The purpose of this research was to investigate how the use of manipulatives could improve low academic achievers in the mathematics classroom. The researcher used two groups of students with one group as the control group and one as the experimental group. They both were given a pre-test at the beginning of the study to see where the students stood academically. The control group was taught three math lessons on adding and subtracting whole numbers and the experimental group was taught the same lesson. The researcher allowed the experimental group to use physical counter blocks to help the students work out the different problems with the use of numbers between 1 and 20.

After, the instructional period the researcher administered a post-test to both groups with a percentage scale of 0 to 100 used to evaluate the scores of both groups. The scale was chose to help determine if there was any statistical difference in the students' academic achievement in mathematics. The researcher found no significant difference in the level of knowledge of adding and subtracting whole numbers. Therefore, a two-sample, paired data t-test was run on the post-test scores of both groups of students' to determine if any significant difference could be found in students' scores. This was at the .05 confidence level. It was revealed through this statistical test, that students using the counter blocks as a manipulative during the mathematic lessons taught by the researcher performed better on the post-test.

Conclusion

In today's classroom instruction, teachers are using all new types and forms of manipulatives to help their students learn. This research identifies the importance of the use of manipulatives and strategies for improving academic achievement in mathematics among elementary students. Manipulatives do increase academic achievement among low achieving elementary students. Many researchers have shown the impact of students' progression in the mathematics classroom by the use of manipulatives. They believe that there is still a need for further research and strategies with the use of manipulatives. The era that this society lives in has a new generation of students that need this type of instruction while they are growing up. When using the manipulatives during the instructional lessons the students were excited and motivated to learn. Even though, the students did not all score has high as the control group the students still showed tremendous improvement in their pre/post tests. The control group showed improvement but not as much of a difference as the experimental group.

The researcher found that the use of manipulatives during instruction provides the students with different techniques to get to the solution. It has been suggested by the researcher that not all students need manipulatives, but they do all need some type of motivation or incentive to help them succeed in mathematics. Mathematics is what makes this society function. This action research project helped the researcher determine that with the use of manipulatives in the classroom, they can increase the knowledge of low academic achievers in mathematics in elementary school.

Recommendations

Further research is still needed for this topic of concerning manipulatives and resources are still in need of being look into. For the purpose of future studies in the use of manipulatives in the classroom, the following recommendations are made:

1. A different grade level should be used, maybe at the middle school level.
2. A bigger sample could be used. Since the research was based on a small sample of students.
3. Since, the researcher use counter blocks, other forms of manipulatives could be used for the same lesson to get a different outcome.
4. The lesson videotaped. The lesson was physically taught by the researcher.
5. Using a longer time frame to conduct the research. This research was completed in one week.

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Appendix A

Post-Test

1) 9
+ 1

2) 6
+ 4

3) 12
- 2

4) 16
- 4

5) 15
+ 5

6) 13
+ 3

7) 14
- 3

8) 9
- 7

9) 18
- 3

10) 7
+ 3

Appendix B

Post-Test

2) 12
- 2

2) 17
- 6

3) 9
+ 6

4) 16
- 6

5) 5
+ 5

6) 14
- 3

7) 15
- 3

8) 12
+ 7

9) 9
+ 3

10) 8
+ 4

Appendix C

Pre-Test and Post-Test Scores/Changes/Averages

	Pre-Test	Post-Test	Change		Pre-Test	Post-Test	Change
	70	100	30		0	80	80
	60	100	40		30	80	50
	40	100	60		20	50	30
	30	70	40		90	100	10
	70	80	10		20	60	40
	50	100	50		80	100	20
	40	100	60		0	50	50
	30	70	30		80	90	10
Pre-Test AVG	48.75			**Pre-Test AVG**	40.00		
Post-Test AVG	90.00			**Post-Test AVG**		76.25	
		Critical t-value of 0.334116					